GAS JOURNAL, MAY 31, 1939

VOL. 226. 91st YEAR. No. 3967.

Editorial Notes

Mining Subsidence

A JUDGMENT of considerable importance to the Gas Industry has been delivered in the Court of Appeal in the case of Hanson v. the Wearmouth Coal Company, Ltd., and the Sunderland Gas Company. The facts of the case were not to any extent in dispute. The plaintiff, a Mr. Hanson, made a claim in respect of damage done to the house of which he was a weekly tenant, and also to his furniture. The damage was admittedly caused by a gas explosion due to a fracture of the gas main. It was not in dispute that the fracture was caused by the mining operations of the Wearmouth Coal Company, and the question to be decided was whether the Sunderland Gas Company on the one hand, or the Coal Company on the other, were liable in damages to Mr. Hanson, or whether both the Gas Company and the Coal Company were jointly liable.

The case was tried at Assizes by Mr. Justice Hilbery, who held that the Gas Company were solely liable, and could not obtain any contribution from the Coal Company. The Judge held that the Gas Company were liable on the grounds both of negligence and of nuisance. With regard to negligence, it was pointed out that the Company were aware of mining operations, and had taken no steps to protect their mains from the damage which might be expected to occur owing to the working of the coal by which they were supported. It was suggested—and the Judge appears to have accepted the suggestion—that the Gas Company could have substituted steel mains for their existing iron mains, and also introduced flexible joints. With regard to nuisance, the Judge came to the conclusion that the immediate cause of the damage was not the fracture of the main, but the operation of the Gas Company in continuing to supply gas under pressure along the main after its fracture.

From this decision the Gas Company appealed, and the appeal was argued for several days before Lords Justices Scott, Clauson, and Goddard. In the judgment of the Court, which was unanimous, it was pointed out that statutory gas undertakings have a right of support for their pipes only in so far as they have compensated the owners of the minerals for the loss which they may incur owing to their inability to work the minerals by which the pipes are supported. The Sunderland Gas Company had paid no compensation in this case, and therefore could not be said to have acquired any right of support against the mineral owners. Conversely, the mineral owners in working the coal beneath the mains did nothing which from a legal point of view could be regarded as a wrongful act. The Gas Company were therefore *prima facie* liable, in accordance with the well-known maxim of the law that persons who store a dangerous thing are liable for the damage which may occur if that dangerous thing escapes. An exception to this rule would arise where the escape of a dangerous commodity was due to the action of a third party, provided that the persons by whom the dangerous commodity was stored had not themselves been guilty of negligence.

Court of Appeal Decisions

THE Court of Appeal affirmed the decision of Mr. Justice Hilbery that in this case the Gas Company had been guilty of negligence in that they stood by and did nothing, well knowing that the mining operations were in progress. The Court of Appeal did not go so far as to say that the correct course for the Gas Company to have taken was to have provided steel mains with flexible joints, but it was obvious that the Court considered that some steps should have been taken by the Gas Company for the protection of their mains. This aspect of the case appears to create a difficult problem for gas undertakings supplying gas in areas where mining operations are prevalent. It appears to us that so long as the law remains in its present unsatisfactory condition some consultation between gas undertakings which are faced with this difficulty might be advocated, in order that some common policy might be adopted to avoid any allegation that fractures arising from mining subsidence were in any way due to the negligence of the gas undertaking.

On the question of nuisance the decision of the Court of Appeal was from the point of view of the Gas Industry more satisfactory. Lord Justice Goddard in his judgment definitely overruled Mr. Justice Hilbery's contention that the immediate cause of the explosion was not the fracture but the fact that the Gas Company continued to supply gas under pressure

after a fracture. The effect of Mr. Justice Hilbery's ruling on this matter if it had been allowed to stand would have had repercussions throughout the Industry which would have been most serious.

Unsatisfactory State of Law

THE case once again calls attention to the unsatisfactory state of the law with regard to the support of mains and pipes in mining areas. So long ago as 1927 the whole question of mining subsidence was investigated by a Royal Commission, but the findings of this body have not received any legislative sanction. With regard to the support of the actual gas-works, certain provisions were incorporated in the Coal Act, 1938. Under this Act, an application may be made by a gas undertaking whose works are or may be affected by mining operations to the Court of Railway and Canal Commission. The Court may order a right of support without necessarily awarding compensation to the Coal Commission as the mineral owners. With regard to pipes, however, the matter is more unsatisfactory. A Bill has been introduced by the Labour Party which might conceivably cover the matter, but there is little chance of this Bill reaching the Statute Book.

The simple fact is that Parliament has given the statutory gas undertaker the right to lay mains and pipes in streets, and has imposed upon them the duty to give and maintain a supply. Is it reasonable to suggest that this obligation can be fulfilled in accordance with the intention of Parliament if at any moment mining operations can deprive the mains of support? It is true that the gas undertaker can purchase the minerals under the pipes, but the effect of this would in many cases be to increase the price of gas to such an extent that it would be beyond the means of the people normally inhabiting these areas to use it. Similarly, the replacement of the existing distribution system with steel mains with flexible joints, even if this course might be effective, would impose a heavy financial burden upon the undertaking. This is surely a matter which demands the most careful investigation.

Coke Oven Gas Supply

THE coke oven gas supply to Newport (Mon.) was the theme of the Presidential Address delivered by Mr. Canning to the Wales and Monmouthshire Association of Gas Engineers and Managers. Prior to giving an outline of the scheme, however, he paid a most eloquent and well-merited tribute to the late Mr. Octavius Thomas, who gave such yeoman service to the Gas Industry in South Wales. His unflagging devotion, energy, and inspiration were truly remarkable, and he wielded a powerful influence in the development of the Association and of gas in the area the Association covers.

The Newport Gas Company began to supply coke oven gas at the end of 1937, the supply being taken from the coke ovens of British Benzol and Coal Distillation, Ltd., at Bedwas. Mr. Canning gave an account of the laying of the main—10·3 miles in length—from the ovens to Newport. A cast iron main with Stanton-Wilson joint was adopted, and the work was carried out under scheduled time. The testing of the joints for soundness set a problem, for the familiar "soap-suds" test is inapplicable to the Stanton-Wilson joint. The problem was, however, ingeniously solved by a member of the Newport Company's staff, Mr. C. B. Felton, and Mr. Canning's reference to the new and "most delicate" test which was devised should prove helpful to others contemplating the laying of mains of the type used by Newport.

The gas is stripped for benzole at the coke ovens, but is purified at the Newport Works, and as sent out to the district it has a very good analysis and contains not more than 4 grains of sulphur per 100 cu.ft. The specific gravity, too, is low—between 0·36 and 0·37. Mr. Canning was able to record that, in spite of the large expenditure involved in the scheme, it has been possible to make a general reduction in the price of gas to consumers and also to offer domestic consumers a two-part tariff with a small fixed quarterly charge and gas at half-price. In addition, special scales have been fixed for the industrial load. Under these conditions and with a gas so low in sulphur, the Newport Gas Company can surely look forward with confidence to a more widespread use of gas in its area of supply.

The only other matter touched upon by Mr. Canning in his Address was the oil gas stand-by plant provided at the Company's works in case of any interruption of the supply of coke oven gas. This plant was described last year in a Paper given by Mr. G. M. Gill and Mr. L. B. Jones to the Institute of Fuel—"JOURNAL" for May 4, 1938. Mr. Canning, while reiterating the claims made for the plant, did not add to the information set out in that Paper. It will be recalled that the reasons which led to its selection were that the gas produced from the oil approximates in composition to coal gas, that the plant is capable of being put into operation at short notice and can be worked with a minimum of labour, that it dispenses with the use of solid fuel—an important point in the event of a coal strike—and that it is low in capital cost and occupies only a small ground area.

Good Management

AT the same meeting of the Wales Association Mr. G. M. Gill read a Paper dealing with the management of gas undertakings. Within small compass it contained a great deal of useful advice—advice the outcome of his experience in holding company work. Mr. Gill has had an exceptional opportunity of inspecting a very large number of gas undertakings in this country during the past few years, and he has come to the one broad conclusion that there is plenty of room for improvement in the way in which many gas-works are managed. He has found in numerous cases that the only practical way of obtaining sufficient revenue to enable district arrangements to be modernized and new tariffs introduced has been to improve works results, make cheaper gas, and spend the money so saved on the district. There is undoubtedly a great deal of wastage of money and opportunity in many gas-works in this country. Without a gas supply of controlled and uniform composition it is no use going all out for sales. This affording of an adequate supply of gas of good and uniform quality is one of the most important duties of a manager, and neglect of the retort house is a very misguided policy.

Then there is the question of coke sales by small undertakings. Here again Mr. Gill's experience shows that the policy pursued by some undertakings leaves room for a good deal of improvement. It is essential that, to meet the local demand for coke and to keep out imported coke, the local undertaking should supply coke properly graded for the particular uses to which it is to be put. Yet in numerous gas-works even to-day no provision is made for grading coke. The practical suggestions which Mr. Gill put forward covered many aspects of gas manufacture and supply, and are to be commended. His remarks on the repair and maintenance of plant and equipment on both works and district were very much to the point. Regarding the cost of such work Mr. Gill said: "The repairs and maintenance item can so easily be a snare and a delusion. If it is high it does not always

follow that wastage is being properly made good. There is sometimes much extravagance under this heading and much also which is not correctly described as repairs and maintenance. Again, when the cost of this item is low there may still have been an adequate replacement of wastage due to the care taken in the original design and construction of the plant and to the efficiency with which it is kept in repair." There is no doubt that keen control on the works and on the district—and this does not necessarily mean elaborate control—undoubtedly can quickly transform a slipshod undertaking into a live concern. Proper control can infuse a new outlook on the part of all engaged in the undertaking, and, by unfolding the possibilities which lie before good gas service, bring renewed confidence and fresh vigour. And in this connexion the suggestions made by Mr. Gill in his compact Paper ought to prove very helpful indeed.

An Address to Juniors

WHEN Mr. George Dixon, who will shortly assume office as President of The Institution of Gas Engineers, speaks he has always something interesting and very much to the point to impart. His Address to the Midland Junior Gas Association on May 11 was no exception. It was a most encouraging and stimulating Address and full of sound advice. It could have been thought out and phrased only by one who had taken a long and keen interest in the Juniors and who had himself benefited greatly by participating actively in Junior Association work and activities. There are to-day over 1,800 members in the Junior Gas Associations affiliated to the Joint Junior Council. They are an important body of workers, and their work is to-day more than ever before watched and encouraged by the Institution. Every junior, said Mr. Dixon, should realize that he is a valued link in the chain of the organization of the Industry, and should understand, too, how his work is linked up with the general scheme of things. All juniors will benefit from reading Mr. Dixon's Address and taking the lessons to be learnt from it to heart. Mr. Dixon made it clear that he wished to speak particularly to what he termed the "junior junior"—the newcomers to the Industry—and certainly what he had to say should make those who have recently joined the Industry enthusiastic in its service and alive to its possibilities and their own prospects. The Industry has a great deal to offer the keen and intelligent worker.

Two points from Mr. Dixon's Address may well be emphasized here. The first relates to promotion within the Industry and the matter of applications for posts. Far too many applicants have not the ability to set out an attractive summary of their qualifications in an application for the post they seek. They should cultivate this ability and try to picture the chief's problems in making a selection. Every chief must from time to time be confronted with dozens of applications which are badly phrased and "padded" with irrelevant matter of no value as supporting arguments in favour of the candidate. The presentation of qualifications to secure a suitable opening or advancement require much consideration. In this connexion we recall the observations of Sir Frederick West in the William Young Memorial Lecture he gave last September. The essential function of a written application, he said, is to establish clearly and concisely the possession of the necessary qualifications for the position. It must not be too verbose and it must present to the reader clearly and quickly a sufficiently convincing *prima facie* case for the suitability of the candidate. Again, all too frequently insufficient consideration is given beforehand to the presentation of his case by a candidate who has secured an interview. He fails to secure advancement not because he does not possess the necessary qualifications but because he lacks the capacity to present his own case clearly and convincingly.

The other problem touched upon by Mr. Dixon in his Address was that of the public lighting load. True, the public lighting load by gas is increasing, not decreasing, but is it increasing at the rate which would be possible if greater interest was taken in and more time and energy devoted to the development of the load? Competition from electricity becomes increasingly keen. Lighting has become a scientific technique; installations of every type call for skilled planning. Can it be said that all concerned or who should be concerned in this work in the Gas Industry are taking the trouble to keep abreast of the times, in touch with the most modern practice? Why is it that some towns are able to keep and increase their gas lighting loads while others are losing ground? Mr. Dixon pointed to the wonderful strides made over the past few years on the industrial gas side "largely because those responsible for the formation of the Industrial Centres organized all the available forces to study the problems, to assess the nature and strength of the competition, and to present a true and not overstated case to their consumers." And he suggested that the lighting problem might well be tackled on similar lines. He also put forward the useful suggestion that the Junior Associations should form study groups to add their influence to the Senior Associations. This would enable them to give of their best in an endeavour to improve the present position of the lighting load.

Better Gas Service

On a later page will be found a report of the annual meeting of Associated Gas and Water Undertakings, Ltd., at which Mr. W. H. Bennett, in his Address as Chairman, was able to point to the substantial progress made during the year towards giving consumers a more efficient and more satisfactory gas service. Controlling interests were acquired in five gas companies, bringing the total number of associated undertakings up to 23. Since the Company commenced active operations five years ago, much has been accomplished to consolidate the gas load. New vertical retort installations have been built, or are under construction, by five undertakings. Two works have been shut down and a supply taken in bulk from other works. New gasholders have been erected at the works of four undertakings. Mains extensions of a major character have been carried out, affording supplies of gas in new areas, and in no fewer than 15 undertakings have showrooms been provided or enlarged. As a result of all this, the companies have experienced increased business and consumers have benefited by better service. And, in spite of the increase in cost of coal and raw materials generally, in the majority of the undertakings controlled no increase in the price of gas has been made.

Forthcoming Engagements

June.

1.—L.C.C.A.—Finance Committee, 10.45. a.m.; Executive Committee, 11.15 a.m.; Central Committee, 2.30 p.m.
6.—I.G.E.—Council, Institution of Civil Engineers, 9.30 a.m.
6, 7, 8, and 9.—I.G.E.—Seventy-Sixth Annual General Meeting, Institution of Civil Engineers.
10.—Manchester and District Juniors.—Visit to Chester.
12.—L.C.C.A.—Technical Committee, 2.30 p.m.
14.—Coke Salesmen's Circle.—Visit to Works and Laboratories of Eagle Range and Grate Company, Ltd., Aston, Birmingham.
21.—I.G.E.—Domestic Heating Committee, 2.30 p.m.
22.—S.B.G.I.—Council Meeting, 11.15 a.m.
23.—North of England G.M.A. (Auxiliary Section).—Half-Yearly Meeting at Newcastle-upon-Tyne and Chairman's Address by Mr. G. J. Duncan.

Personal

The Deputy Gas Engineer, Mr. C. S. DAVIES, is to be appointed Gas Engineer and Manager for Chesterfield Corporation, in succession to Mr. H. DAVIES, whose retirement has already been reported in these columns. The new Engineer has been Assistant for the past ten years, and received mechanical and constructional training with Messrs. Bryan Donkin, Chesterfield, and Robert Dempster and Son, Ltd., Elland.

* * *

The Blairgowrie Gas Company have appointed Mr. JOSEPH S. EDNEY as Manager in succession to Mr. ARCHIBALD STEWART, who is retiring after twenty-two years' service.

* * *

Mr. SYDNEY SMITH, Assistant Gas Engineer and Manager, Bristol, was at a meeting of the Paisley Town Council on May 24 appointed as Engineer and Manager to the Paisley Corporation Gas Department in succession to Mr. A. S. NISBET, who retires at the end of next month. Mr. Smith, who is thirty-eight, has held his present position since 1934, and prior to that date he was for a number of years Deputy Gas Engineer at Dunfermline. He also for a time held the position of Technical Assistant at the Birkenhead Corporation Gas-Works.

* * *

Mr. GEORGE WRIGHT, Hon. Treasurer of the Lincoln Football F.C., has been appointed Chairman to the Club. He was appointed to the Club's directorate nearly seventeen years ago. Mr. Wright is, of course, Engineer and Manager to the Lincoln Gas Department.

Obituary

The death has occurred at the age of seventy-three of Mr. JOHN WILLIAM STURDY, who, for forty-five years, was Manager of the Easingwold Gas Light and Coke Company.

* * *

It is with much regret that we have to announce the death, on May 23, after a prolonged illness, of Mr. F. G. MCELWEE, Engineer and Manager of Coleraine Borough Council Gas Department. Mr. McElwee was elected President of the Irish Association of Gas Managers at the Annual Meeting last August.

News of the Week

Nine Gas Department Motor Drivers at Bradford have received awards from the National "Safety First" Association for safe driving during 1938.

Notice is Given by the Bridport Gas Company, pursuant to the Bridport Gas Order, 1935, that on and after July 1 they intend to supply gas of a calorific value of 450 B.Th.U. per cu.ft. instead of 475 B.Th.U. as heretofore.

An Extension of Their Limits of Supply is the principal provision of a Special Order for which the Gainsborough Urban District Council Gas Department intend to apply to the Board of Trade under the Gas Undertakings Acts, 1920 to 1934.

A Fire caused by the ignition of a quantity of oil involved a 40 ft. coal hoist at Market Harborough Gas-Works on May 23. The fire was so fierce for a few minutes that corrugated iron sheeting was melted. Workmen quickly had the outbreak under control.

The Abolition of Differential Charges in the outer districts of the Plymouth and Stonehouse Gas Light and Coke Company's area of supply was resolved upon by the Directors of the Company at a meeting on Thursday, May 25. After the midsummer meter readings gas charges will be uniform throughout the whole area of supply.

Increased Gas Charges were decided upon at a meeting on May 23 of the Leicester City Council, who approved a recommendation of the Gas Committee that as from the midsummer meter readings the price of gas to ordinary consumers for the first 10,000 cu.ft. used for lighting and general purposes be increased by 0·74d. to 10·44d. per therm, or by 3·35d. to 3s. 11d. per 1,000 cu.ft.

Concrete Foundations have been completed for the new 169 ft. high gasholder for the Lincoln Gas-Works. This new gasholder will be twice the size of any of the existing holders in the City and will have capacity of 3 million cu.ft. when ready for use. It will probably be completed towards the end of this year. The City will then have a 24 hours' reserve supply of gas instead of 12 hours.

The Electrolux Gas Refrigerator was the subject of demonstrations held throughout the week beginning May 22 in the Perth Corporation Gas Showrooms. They were given twice daily by Mrs. Christina Papineau, of Electrolux, Ltd. The opening ceremony was performed by Mr. A. C. Rea, Perth Corporation Gas Manager, Mr. W. P. Rae, Electrolux Refrigerator Manager for Scotland, being present.

Owing to the Increased Gas Consumption in Hertford, Ware, and District, the area covered by the Hertford Works of the Tottenham and District Gas Company, larger storage capacity has become necessary. The Company is erecting a gasholder which will have a capacity of 1 million cu.ft. The softness of the ground at the site has necessitated the driving of 236 reinforced concrete piles to a depth of 36 to 40 ft

Cookery Demonstrations were recently held by Stoves, Ltd., at Basingstoke, Miss E. D. Newberry being the demonstrator, and at Southampton, where Miss Hume acted as demonstrator, and large attendances were reported.

To Change the Name of the Undertaking to the West Cheshire Gas Company is one of the provisions of a Special Order for which the Runcorn and District Gas Company intend to apply to the Board of Trade under the Gas Undertakings Acts, 1920 to 1934. The Order also seeks to confirm the agreement for the purchase by the Company of the Ellesmere Port Urban District Council's gas undertaking and to include within the Company's limits the area previously supplied by the Council. The Runcorn Company is one of the United Kingdom Gas Corporation group and, according to the latest available figures, has an annual make of 160 million cu.ft. The output of the Ellesmere Port undertaking is given as 129 millions.

A Decision to Form a Midlands Sub-Section of the Illuminating Engineering Society with headquarters at Nottingham was made as the result of a meeting held at the Nottingham Corporation Gas Department's Demonstration Theatre on May 23. Mr. F. Walker presided. Mr. Walker was elected Chairman, with Mr. C. S. Caunt, Secretary. At present the Sub-Section has a membership of 39. Mr. Percy Good (National President) and Mr. J. Stewart Dow (National Secretary) were present. Mr. George Dixon (Nottingham Gas Engineer and Manager), welcoming the formation of the Sub-Section in Nottingham, pointed out that the provincial problems were quite different from London problems. "Quite often," he said, "we get people in London putting forward their ideas, and they are hopeless for the Provinces."

Amalgamation and Grouping

Middlesbrough and Stokesley.

The Special Order authorizing the purchase of the Stokesley Gas Undertaking by the Middlesbrough Corporation has been confirmed by Parliament.

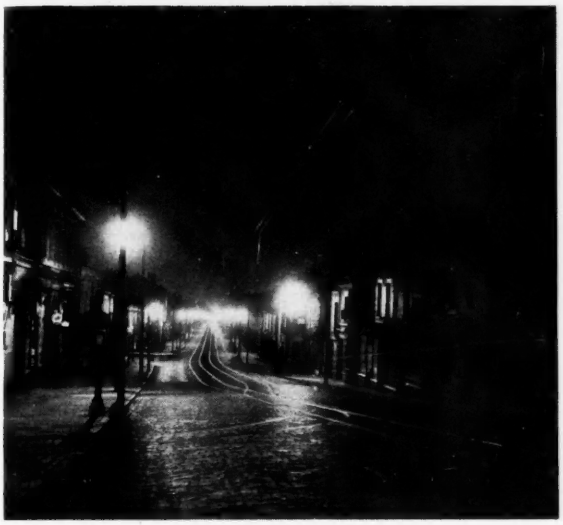
United Kingdom and Stockport.

The United Kingdom Gas Corporation, Ltd., has made an offer for the purchase of the Stockport Gas Undertaking, and the Town Council has appointed a committee to consider the offer.

C.O.L. Intermittent Vertical Chambers

The Paper which Mr. Edmund Bates presented to the Manchester and District Junior Gas Association on March 4, on the operation of intermittent vertical chambers combined with dry coke cooling at Stalybridge, has been reproduced in attractive brochure form by Gas Chambers and Coke Ovens, Ltd., Artillery House, Westminster, S.W. 1.

Lighting Improvements at Coventry



Our photograph shows the improved gas street lighting along Stoney Stanton Road, Coventry. This is an important thoroughfare approximately two miles in length. The average width of carriageway is 30 ft., and the lamps used are Parkinson's "Maxilla" 8-lt. units fitted with long Bijou mantles. They are spaced approximately 120 ft. apart in staggered formation and mounted on Stanton concrete columns at 16 ft. 6 in. from ground level, giving a light source of 18 ft. The illumination generally is very even, and the visibility of objects and pedestrians at a distance of two to three hundred yards is excellent.

A.R.P. Notes

Safeguarding Motor Spirit Supplies.

In view of the importance of protecting supplies of motor spirit, the National Benzole Company have undertaken an extensive A.R.P. scheme embracing branch depôts, installations, storage centres, and offices throughout the country.

Owing to the highly inflammable nature of motor spirit, special precautions have been taken to ensure the safety not only of the personnel and fuel at storage depôts, but of surrounding life and property. To localize any outbreak, the flow of inflammable spirit is restricted by retaining walls, and additional fire walls are being erected at considerable cost. Staffs at depôts have been instructed by the Company's A.R.P. officer. All key-men are fully experienced and trained, and in addition many workers have taken courses of first aid.

The head office at Wellington House, London, is provided with blast, splinter, and gas proof shelters in the basement. In a recent test the staff were in the shelters and all wardens at their posts within three minutes of the syren sounding.

I.C.E. Lecturer.

A series of three lectures has been arranged at the Institution of Civil Engineers during June so that members may be informed of the latest developments in A.R.P. practice They are: *Tuesday, June* 6 (at 6.0 p.m.).—"Experimental Work on A.R.P.," by Dr. R. E. Stradling, C.B., M.C., M.Inst.C.E., Chief Adviser, Research and Experiment, A.R.P. Dept., Home Office. *Monday, June* 12 (6.0 p.m.).—"Camouflage," by Col. F. J. Wyatt, O.B.E., M.C., of the Royal Aircraft Establishment, South Farnborough. *Tuesday, June* 20 (6.0 p.m.).—"The Design of Bomb-proof Shelters," by Dr. David Anderson, M.Inst.C.E., Chairman, Design Panel, Engineering Precautions (Air Raid) Committee.

The following Lecture has also been arranged to let members know the duties which a civilian engineer may be called upon to carry out when working with military engineers in war: *Tuesday, June* 27 (6.0 p.m.).—"The Work of the Military Engineer in War," by Brigadier C. A. Bird, D.S.O., Chief Engineer, Aldershot Command.

Women's Gas Council

A large gathering of members of the Southend-on-Sea Branch of the Women's Gas Council attended the monthly meeting at the Masonic Hall, Southend, on May 24, to welcome their new President, Lady Milne-Watson, who is a Vice-President of the national organization of the Women's Gas Council.

Lady Milne-Watson, who was introduced by the Chairman of the local Branch (Mrs. F. Fardell), expressed appreciation of the honour of becoming President of such a large and successful Branch. "It has astonished me," she said, "to find how large the Southend Branch is, with a membership of 500 in such a short time."

The success of a Branch, she continued, depended on two factors —the co-operation and assistance of the members, and the efficiency of the members and officers of the Committee, which, in their case, had been so ably assisted by their Chairman (Mrs. Fardell), their Secretary (Mrs. H. M. Royle), and by Miss Ellington Wright, M.B.E., who had helped with the formation of the Branch three years ago.

Lady Milne-Watson also took part in the little ceremony which marked the joining up of the 500th member of the Branch.

Mrs. Royle, the Secretary, had promised a prize to the 500th member to join the Branch, and Lady Milne-Watson was able to hand the gift to Mrs. Free, whose good fortune it was to bring the total membership up to that figure.

Mrs. Free presented the Council's new President with a beautiful bouquet.

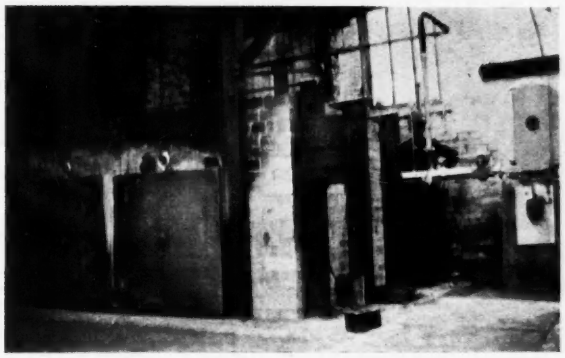
After the routine business of the meeting had been dealt with, Mrs. Wilkins, showing an extremely comprehensive knowledge of her subject, traced the history of the art of embroidery through the centuries, concluding with suggestions for original designs by the amateur needlewoman. Later, Miss Doris Newman recited.

Aberdeen's Stand-By Plant

With a view to safeguarding the City's gas supply, Aberdeen Town Council Gas Committee instructed Mr. H. S. Milne, Gas Engineer, on May 25 to purchase and install a stand-by electric generating plant.

Mr. Milne reported that the plant, as well as ensuring gas production in normal times, would also be of the utmost value in time of emergency. He explained that, as most of the coal and coke-handling plant at the Gas-Works was driven by means of electric motors, there would be considerable disorganization to gas production in the event of interference in the public supply of electric current. Considering the importance of the conveying and elevating plant serving the vertical retort installations, a stand-by source of electricity should be made available. The Gas Engineer suggested that a steam-driven direct current generating plant of sixty kilowatts capacity would be sufficient to ensure the operation of the machines essential for gas-making.

Annealing at Stalybridge



Our photograph shows a small annealing furnace designed and built by the Gas Department and recently put to work treating dog nails and blueing tacks. It replaces a furnace converted from coal to gas firing, the old furnace taking 8 cwt. per charge for a gas consumption of 1,000 cu.ft. per hour. The new furnace will take 12 cwt. per charge and will do the work in 45 minutes less time for a consumption of between 900 and 1,000 cu.ft. per hour.

Wales and Monmouthshire Association of Gas Engineers and Managers

The Thirty-Fourth Annual Meeting of Members of the Wales and Monmouthshire Association of Gas Engineers and Managers was held at the Assembly Rooms, Town Hall, Newport (Mon.), on Thursday, May 25, the PRESIDENT (Mr. J. H. Canning, O.B.E., J.P., Director of the Newport (Mon.) Gas Company) presiding.

The PRESIDENT introduced the Deputy-Mayor, Councillor W. HAROLD JOHN, who extended a civic welcome to the delegates, expressing regret at the unavoidable absence of the Mayor, Alderman J. R. Wardell. They offered the congratulations of the town to Mr. Canning upon his appointment to the Board of the Newport (Mon.) Gas Company—a most deserved honour. He also tendered his congratulations to Mr. Snelling upon his promotion to the position of General Manager and Secretary of the Company. They were most proud that the Association had had its beginnings in the town, for it was the late Alderman Thomas Canning who founded the Association in 1905. His son was carrying on the high traditions of his father and the members had recognized this by electing him President for a third term of office. "The work of the Canning family in Newport," he said, "is well-known, and their work for the Gas Industry is better known to you. Their record is one of which the Gas Company of Newport and the citizens of this town are rightly proud."

The PRESIDENT then referred to a number of apologies for absence, which included one from Mr. Robert Robertson, President of The Institution of Gas Engineers, who had made previous arrangements to attend the meeting of the Eastern Counties Association at Grimsby, and another from Colonel O. B. F. Planck, D.S.O., Chairman of the Society of British Gas Industries. Another telegram had been received from the President and members of the Eastern Counties Association, sending greetings and every good wish for a successful meeting. On the proposition of the PRESIDENT it was decided to send a wire thanking them for, and reciprocating, their greetings. This was unanimously agreed to.

The PRESIDENT referred to the serious losses sustained by the Association in the deaths of Mr. Octavius Thomas and Mr. T. B. Pearson. As reference would be made later to Mr. Thomas, he would say nothing more at that juncture about him, but he reminded the members that Mr. Pearson was for a number of years responsible for the conduct of the Pontypool Gas and Water Company and was a most valued member of the Association. As a mark of respect to the memory of these gentlemen, members stood in silence.

The minutes of the last meeting, read by the ASSISTANT HON. SECRETARY (Mr. Wilfrid Jones, Cardiff), were taken as read. Having been proposed and seconded, these were signed by the President.

New Members.

Thereafter the election of the following Members, Hon. Member, and Associates was moved by Mr. J. H. CANNING, Jnr. (Welshpool), and seconded by Mr. F. DUPONT (Brecon).

Members.—Messrs. R. H. Bone (Cardiff Gas Light and Coke Company), G. M. Gill (15, Moorgate, London, E.C. 2), A. L. Morris (Cheltenham and District Gas Company), and R. S. Snelling (Newport (Mon.) Gas Company).

Hon. Member.—Mr. J. Sadler (Parkinson Stove Company, Ltd., Newport, Mon.).

Associates.—Messrs. R. D. Griffith (Old Colwyn, North Wales), T. P. Reay (Cannon Iron Foundries, Ltd., Bilston), and H. J. Starns (Llandaff, Cardiff).

The PRESIDENT, referring to the election to Hon. Membership of Mr. Sadler, said that it had been the custom to confer this distinction upon gentlemen who had not the necessary technical qualifications to render them eligible as members of the Association, but who had rendered valuable service to it. Mr. Sadler had most unselfishly taken up a lot of work to make their meetings a success, and the President felt they would be failing in their duty if they were not to recognize such devoted service as that rendered to the Association by Mr. Sadler. He had also helped Mr. Thomas in every way during the latter's last few years.

The ASSISTANT HON. SECRETARY then read the Report of the Council for the past year, in the course of which it was stated that the Association's membership was now 160, comprising of 89 Members, three Hon. Members, 66 Associates, and two Students—an increase of three during the year. Receipts for the year amounted to £147 15s. 7d., and expenditure to £141 12s. 5d., leaving, with the balance brought forward, a sum of £92 0s. 1d., in the hands of the Treasurer, together with £100 of 2½% Consols.

Election of Officers.

The Council recommended the election of the following officers for the ensuing year to take office from the September Meeting:

President.—Mr. J. Prosser Jones.
Vice-President.—Mr. J. F. Rust.
Members of Council.—Mr. E. M. Edwards and Mr. J. H. Jones.
Treasurer.—Mr. J. H. Canning, O.B.E., J.P.
Hon. Secretary.—Vacant.
Assistant Hon. Secretary.—Mr. Wilfrid Jones.
Auditors.—Mr. W. T. Kenshole and Mr. S. Walker.

The adoption of the Report and Accounts was moved by Mr. J. PROSSER JONES (Cardiff) and seconded by Mr. H. G. HORWOOD (Llanelly).

The PRESIDENT then proposed that Mr. Prosser Jones be elected President for the ensuing year. In the normal state of affairs, Mr. Horwood would have succeeded Mr. Canning as President, but he found it impossible to accept office owing to stress of duties. They had therefore asked Mr. Prosser Jones to accept office. He felt sure they were all of the opinion that this honour should have come to Mr. Prosser Jones long ago, but unfortunately he had been such a busy man that he had been unable to accept. Now he had consented. The proposition was seconded by Mr. BARTON GRAINGER and carried unanimously. Mr. PROSSER JONES acknowledged the honour conferred on him in suitable terms.

The PRESIDENT'S proposition that the election of the Secretary for the ensuing year be left to the further consideration of the Council, having been agreed to, the election of Mr. Wilfrid Jones for a further term of office as Assistant Hon. Secretary was moved by Mr. B. J. BELL (Cardiff), seconded by Mr. J. H. CANNING, Jnr., and unanimously carried.

The PRESIDENT then reminded the members of the service Mr. Wilfrid Jones had given to the Association and in particular the very devoted assistance he had given to their late friend, Mr. Thomas. He had witnessed the wonderful way in which Mr. Jones looked after things for Mr. Thomas until the end, thus fulfilling a wish of Mr. Thomas. This, he thought, they should recognize in some tangible manner, and he asked Mr. Jones to accept from them a silver salver bearing the inscription: "Presented by the Wales and Monmouthshire Association of Gas Engineers and Managers to Mr. Wilfrid Jones as a token of their appreciation for his many services to Mr. Octavius Thomas."

The ASSISTANT HON. SECRETARY, thanking the members for this token, said it had given him the greatest possible pleasure to help Mr. Thomas. By that service itself he had already been more than repaid.

The Institution Benevolent Fund.

The PRESIDENT then proposed that a grant of ten guineas be made to the Benevolent Fund of The Institution of Gas Engineers. This was cordially seconded by Mr. W. H. JOHNS (Swansea), who said he would like to see the amount increased as they had such a favourable balance on their

accounts; the Fund could do with greater support than it had received to-day.

An Octavius Thomas Memorial.

The perpetuation of the memory of the late Octavius Thomas was the object of the next proposition by the President, which was that a fund be inaugurated and the proceeds invested and the interest paid annually to the Benevolent Fund of The Institution of Gas Engineers in Mr. Thomas's memory. Enlarging on the proposal, the President said the Council felt that, if such a fund were to be established, it should be in support of some object which Mr. Thomas had at heart. It was proposed to establish this fund by appealing to members of the Association, friends of Mr. Thomas, and undertakings which had benefited from his help to obtain a capital sum which could be invested in the names of trustees. The interest from the gilt-edged securities would be distributed annually in the name of the Octavius Thomas Memorial Fund to the Benevolent Fund of the Institution.

The proposition was warmly supported by Mr. MADDEN, who knew that the Benevolent Fund had been a cause very dear to the heart of Mr. Thomas, who had felt, as Mr. Johns did that day, that they should lend further strength to the Fund. There could be no better way than that embodied in the proposition of perpetuating the memory of their friend.

Further support for the proposition came from Mr. W. CLARK JACKSON (Neath), who, however, felt at the same time that another of Mr. Thomas's objectives—that of furthering the interests of the young men of the Industry—should receive recognition from the Fund. He wondered would it not be possible to obtain such a sum to provide in addition to an annual contribution to the Benevolent Fund some special annual prize for outstanding service to the Wales and Monmouthshire Junior Gas Association. In thanking Mr. Jackson, the PRESIDENT drew his attention to the fact that they already had funds for that purpose, and asked Mr. Jackson if he would be agreeable to leave it to the Council. Mr. JACKSON agreed, so long as the Fund were in perpetuity.

Mr. C. R. AVERILL suggested that the Fund might be raised quite well by a small addition to subscriptions, but the PRESIDENT pointed out that this might not be satisfactory, having regard to the fact that they wished the Fund to be permanent, whereas the personnel of the Association was not permanent. Mr. MADDEN, having suggested that the Fund could be increased from year to year by members' individual subscriptions, the proposition was agreed to unanimously.

The Presidential Address.

Mr. CANNING then delivered his Presidential Address, which will be found on other pages of this issue.

Mr. E. ABLETT (Swansea), proposing a hearty vote of thanks to Mr. Canning for his Address, said it was of that quality which they had come to expect from Mr. Canning. In the past he had set himself a very high standard which he had more than fully maintained in his Address. The expression of their gratitude was in no way formal but really sincere.

Mr. W. H. JOHNS (Swansea) seconded the vote of thanks, taking the opportunity of saying how pleased they all were that Mr. Canning had brought the work outlined in the second part of his Address to such a successful conclusion. It would be recalled by members that it was in the course of this work that Mr. Canning met with his severe accident. When he was laid up they all thought of him continuously, and they were very relieved when he was back again in harness.

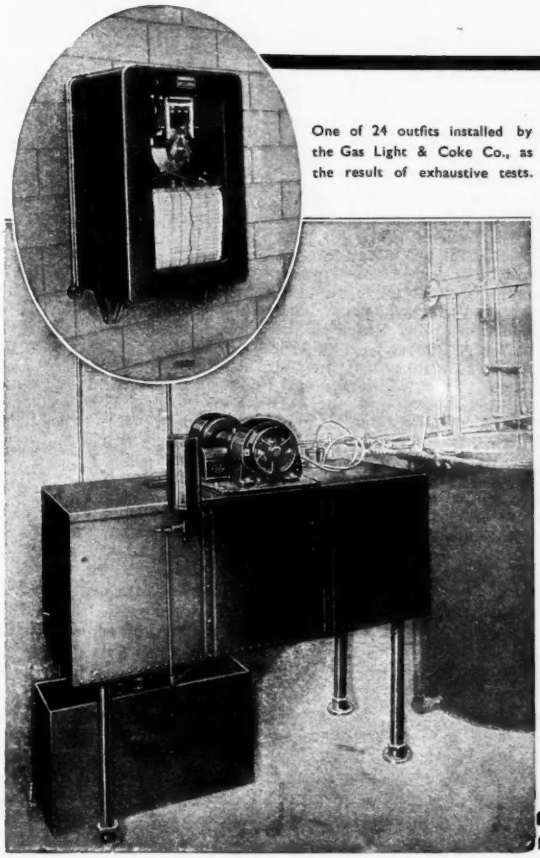
The vote of thanks having been carried with acclamation, the PRESIDENT briefly replied.

The PRESIDENT then called upon Mr. G. M. Gill, M.Inst.Mech.E., Consulting Engineer, Director and Chief Engineer of the Severn Valley Gas Corporation, Ltd., and Gas Consolidation, Ltd., to introduce his Paper entitled, "Management of Gas Undertakings," which will be found on other pages of this issue.

LUNCHEON.

Members then adjourned to the Westgate Hotel for luncheon, when the chair was taken by the President.

"The Town and Trade of Newport, Mon." was proposed by Mr. H. D. MADDEN, who coupled with the toast the name of the



One of 24 outfits installed by the Gas Light & Coke Co., as the result of exhaustive tests.

THOMAS CALORIMETER

Approved by the Gas Referees.

AUTOMATIC
ACCURATE
CONTINUOUS RECORDS
NO CORRECTIONS
NO CALCULATIONS

This calorimeter is embodied in the
THOMAS TOTAL HEAT METER
as supplied to the United Steel Companies
Rother Vale Collieries, Orgreave By-Product Plant

May we send you our descriptive LIST 953 D ?

CAMBRIDGE
INSTRUMENT CO LTD

WORKS:- LONDON & CAMBRIDGE
Head Office & Showrooms :- 13 GROSVENOR PLACE LONDON, S.W.1.

Parkinson & Cowan, Ltd.

Extended Activities.—Lt.-Col. Woodall's Address

The 39th ordinary general meeting of Parkinson & Cowan, Ltd., was held on May 25 at Terminal House, Grosvenor Gardens, London, S.W. Lt.-Col. Harold W. Woodall, C.I.E., M.Inst.C.E. (Chairman and Managing Director) presided.

The Secretary (Mr. A. Gordon, F.C.I.S.), having read the notice convening the meeting and the report of the Auditors,

The Chairman, after dealing with the accounts for the past year, said: The work of the research and development departments of the Parkinson Stove Company continues to produce admirable results and is keeping our various products well to the fore.

Turnover is being well maintained, and the streamlined design that we introduced with the "Renown" has found universal favour. This cooker has been adopted by practically all gas undertakings throughout the country, and the many thousands in use are giving excellent service. While reasonable competition is a desirable thing, the extent to which it is carried in our Industry to-day has become a handicap to production, for whereas models used to remain fashionable for considerable periods, now each year brings its particular fashions. The cost of such alterations is much increased owing to increased mechanization and mass production methods, involving as they do with each change of pattern the provision of new sets of tools at a very heavy outlay. Mass production methods are part of the present make-up of industry, but their profitable use is directly dependent on the number of appliances which can be produced off each set of tools.

Production Standardization.

With a view to cheapening production large sums of money have been spent in making the Parkinson Stove Company's works the most efficient producing unit of its kind. Brasswork and other important accessory items are produced by the most modern machinery in our own factories. Component parts of the Parkinson cookers have been studied with a view to ensuring the minimum cost of maintenance to gas undertakings, and we are endeavouring—so far as possible—to standardize our various components and appliances. Our friends of the Gas Industry can largely assist in keeping down manufacturing and maintenance costs by adhering to the standard article produced and not asking for variations which may appear small individually, but which collectively involve a very heavy addition to the cost of manufacture. We shall very much appreciate their help in this direction.

Meter Department.

Our meter business has not been quite so fortunately situated because the demand for meters is limited by the requirements of the public utility undertakings, and this, again, is largely affected by the building programme. No effort on the part of manufacturers can increase the size of the market, and there was a noticeable reduction in demand after the September crisis.

Australasia.

In Australasia the bulk of sales has been generally maintained, but prices have not risen to an extent commensurate with increases in the cost of labour and material. In addition, the cost of defence falls very heavily on young nations with a widely scattered population, and we have to bear our share of defence measures in the Antipodes as well as at home.

Coal and National Economy.

The threat of war may do some good in calling attention to the urgent necessity for steps to be taken to secure the proper utilization of our greatest mineral asset—coal.

Smoke pollution and the evils attendant on it have been matters of urgent public importance for many years past. Technicians claim that more people are killed by smoke than by road accidents and that smoke costs the average family more than £3 per year. As Mr. A. M. Paddon stated in his Presidential Address to the British Commercial Gas Association—unnecessary coal smoke, if it were arrested and treated in the primary processes of a gas-works, would produce tar for our motor roads, antiseptics for our hospitals, fertilizers for our fields, drugs for a pharmacopœia, fuel for our motor-cars and aeroplanes, and high explosives for our national defence. All these desirable ends can be attained by carbonizing coal in gas-works and relying on gas and coke as the main sources of domestic and industrial heat.

Our chief business lies was gas undertakings, and it should be the particular business of all our shareholders to drive home to their Members of Parliament and public authorities the senseless waste of burning raw coal, particularly in these days when the national safety is so urgently dependent on the various products obtained by the economic treatment of this great national asset.

As previously mentioned, one of our subsidiaries has acquired an exclusive British Empire licence for the manufacture of a wide range of scientific equipment, extending far beyond the electricity meter field in which that subsidiary had hitherto been exclusively interested. The licence agreement will enable the Company to extend its interests step by step into the manufacture of equipment such as electrical protective gear, distant gas and electric metering systems, large water meters, and miscellaneous measuring and controlling instruments of many kinds. Much of this work is of a highly specialized nature, and consequently less competitive than the Company's existing lines. The operations of the Company in these fields should, as time goes on, considerably increase its turnover, profits, and reputation.

Thanks to Staff.

I cannot bring my remarks to a close without once more expressing, on behalf of my colleagues and myself, our thanks for the work of our staff and employees. It is customary for this expression of appreciation to take its place at the end of the Chairman's speech, and, as a consequence, there is a danger that it may be taken as a matter of merely formal record. It is hardly necessary for me to assure you ladies and gentlemen who have taken the interest to attend this meeting that such is far from being the case. The work of our staff during the past very difficult year has been admirable in every way and has contributed very largely to the present position of the Company. Our relations with our employees continue to be happy ones and will, I hope, continue so for many years to come.

The report and accounts were unanimously adopted and a hearty vote of thanks was passed to the Chairman, Directors, and staff.

WALES AND MONMOUTHSHIRE GAS ASSOCIATION.

(*Continued from p. 601.*)

Deputy-Mayor. He briefly traced the history of the town, recalling that this was the centenary year of the Chartist Riots, and it was interesting to note that a reminder of that troublesome time was to be found in bullet-marks on pillars at the door-way of the Westgate Hotel, which was the temporary headquarters of the military. He knew many of the citizens of Newport, and had found them to be a most progressive people. The town was now engaged in building a magnificent Civic Centre in Clytha Park, where, at Aragon House, lived one of his best friends, the President's late father.

The DEPUTY-MAYOR OF NEWPORT, in his reply, spoke of the excellent relations existing between the Newport Electricity Committee and the Gas Company, which he characterized as being most happy since neither could accuse the other of trading to its disadvantage. He did suggest that gas was in some degree indebted to the advent of electricity. Referring to the new showrooms of the Newport Company, he said it was obvious that the Gas Industry was out to meet the challenge of electricity. In conclusion, he thanked the Association for their reception and hospitality.

Mr. R. WILSON BARTLETT, J.P., Director, Severn Valley Gas Corporation, Ltd., proposed the toast of the Association, with which he coupled the name of the President, who, he observed, was occupying the chair for the third time. Mr. Canning had spent a lifetime in his profession, and he would like to congratulate him on his election to the Board of the Newport Company. The Association was formed in 1905, and there were present at this luncheon some four or five members who attended its first meeting. To these gentlemen was due all honour for the healthy condition in which they found the Association to-day. He also congratulated members on electing as their Junior Vice-President Mr. J. F. Rust, Engineer of the Newport Company, which he had served under Mr. Canning for a great number of years.

The PRESIDENT, having thanked Mr. Bartlett for his kind words, went on to welcome two friends, Mr. W. J. Smith, Secretary of the National Gas Council, and Dr. W. T. K. Braunholtz, Secretary of The Institution of Gas Engineers.

Visits to Bedwas and Crindau.

After lunch, members proceeded to Bedwas, on the kind invitation of the British Benzole and Coal Distillation, Ltd., to inspect the coke ovens from which Newport and District now receive their gas supply. Tea was later taken at the Westgate Hotel by members as the guests of the Directors of the Newport (Mon.) Gas Company, who were thanked on the proposition of Mr. MADDEN. After tea, a visit was paid to the Crindau Gas-Works, where members inspected the Jones Oil-Gas Plant, which was in operation for the first time. These visits were rendered all the more interesting since some details of the plant concerned had been given by the President in his Address at the Meeting.

Associated Gas and Water Undertakings, Ltd.

Ordinary General Meeting

The Sixth Ordinary General Meeting of Associated Gas and Water Undertakings, Ltd., was held on May 25 at the Incorporated Accountants' Hall, Victoria Embankment, London, W.C. 2.

Mr. W. H. BENNETT (Chairman of the Company) said: The amount of the authorized share capital remains at £3,500,000, although it will be recollected that at an Extraordinary General Meeting in July last 250,000 unissued 4% Irredeemable Cumulative Preference shares were converted into a similar number of 4% Cumulative Preference shares redeemable in 1952.

The issued share capital, however, at the close of the year amounted to £2,231,851, an increase of £522,316, and the Debenture stock has been increased to £750,000 by the issue of a further £250,000 stock. The result is that, notwithstanding the acquisition of further undertakings, the temporary loan by the Company's bankers has been liquidated, and at the end of the year the cash at bank amounted to £7,878.

Following our usual practice, share premium account has been debited with £4,389, being the expenses incurred in connexion with the issue of share capital, Debenture stock, and acquisition expenses. This represents the whole of the expenses in this connexion, with the exception of discount on the issue of the £250,000 Debenture stock to which I have referred. This discount will be written off during the period between the date of issue and that for redemption.

The assets side of the balance-sheet shows that, after writing off the sum of £6,034, our investments stand at £2,874,034, an increase of £498,463 during the year. All our investments are in public utilities in this country. The book value of our freehold and leasehold properties has risen to £28,135.

Turning to the revenue account, dividends and interest from investments have advanced by £17,637 to £108,475, due to the acquisition of further undertakings and to the fact that we have received this year a full year's dividend from companies acquired during the previous year. The incomes from other sources all show similarly satisfactory increases.

With regard to expenditure, I would again draw your attention to the very large sum (£28,327) paid by us by way of income tax. The decrease of £10,234 in bank interest and charges is due to the liquidation of the loan to the Company's bankers, to which I have already referred. With the exception of the new item "Amount written off discount on Debentures—£652," the figures under the other headings are normal, having regard to the enlarged operations of the Company.

As a result of the year's working the accounts show a net profit of £75,150, an increase of nearly £16,000. Although it would permit of the payment of a dividend at a higher rate your Directors think it advisable, in view of the present state of world affairs, to recommend adherence to the usual rate of 5% per annum on the Ordinary capital. If this recommendation is approved the sum carried forward will be £22,760, compared with £17,564 brought in.

Further Acquisitions.

During the year under review controlling interests were acquired in the gas companies at Bideford, Bridgwater, Taunton, Wellington (Somerset), and Godalming, bringing the total number of associated undertakings up to 23, including the subsidiary gas undertaking at Langport of the Taunton Gas Company. It will be observed that all but one of these acquisitions are in Devon and Somerset, thus bringing our gas undertakings in the West Country to seven. In our southern group of 16 gas and gas and electricity undertakings the addition of the Godalming Gas Company is of interest, since the boundary of its area of supply is conterminous with those of our associated undertakings at Guildford and Haslemere.

The returns from our associated undertakings continued to show, despite the abnormal conditions brought about by the international situation, satisfactory increases in the sale of gas, electricity, coke, by-products, and appliances.

New vertical retort installations have been built, or are under construction, by five undertakings. Two gas-works have been shut down and the supply taken in bulk from other works. New gasholders have been erected at the works of four undertakings, affording increased storage capacity but involving considerable expenditure. In no less than 15 undertakings have showrooms been provided or enlarged, as a result of which the Companies have experienced increased business and consumers have benefited by better service. The plant, equipment, and mains of our electricity undertakings have been extended and kept thoroughly up-to-date.

The Chairman concluded by moving the adoption of the report and accounts.

Mr. W. LEES STENNING, M.B.E., J.P. (Deputy-Chairman), seconded the resolution, and it was carried unanimously.

Efficient protection in corrosive atmospheres

In the corrosive atmosphere of the gas works the slightest break in the continuity of the paint film is likely to cause extensive rusting of the metal work —unless an efficient rust-inhibiting priming is used. The best priming for the purpose is Red Lead. A comprehensive evaluation of Red Lead is contained in the Fourth Report of the Corrosion Committee of the Iron and Steel Institute. Copies of the conclusions of this Report are obtainable free on application to this Council.

Advice on specific painting problems can be freely obtained from the Technical Information Bureau of the Lead Industries Development Council, 90, Ebury Street, London, S.W.1. Telephone Sloane 7556.

LEAD PAINTS PROTECT

LEAD INDUSTRIES DEVELOPMENT COUNCIL
REX HOUSE · 38 KING WILLIAM STREET · LONDON · EC4
R127

Testing Modern Gas Appliances - - -

by
K. E. MUIR, Cardiff.

From a Paper at a Meeting of the Wales and Monmouthshire Junior Gas Association, March 18.

Quite a number of gas undertakings do not test their domestic appliances in any way and are quite prepared to sell any appliances providing the consumers will buy them. When too many complaints are received about a certain appliance the undertaking simply stops stocking it. However, this results in dissatisfaction among the consumers, and a remedy must be found. This remedy is quite simple.

If exhaustive tests were to be carried out by each undertaking on a sample of every new appliance before offering it for sale to the consumers, there would be very little danger of dissatisfied consumers.

Since the establishment and equipment of a testing laboratory is costly, and the fact that expert supervision is required to obtain reliable results, it will be seen that smaller undertakings could not afford their own laboratories. They are not to be denied this privilege, however, for there is an industrial centre set up in most areas, and these are equipped with very up-to-date appliance testing laboratories. Additional to this, they have fully qualified assistants who carry out these tests.

To obtain this most necessary advantage, any undertaking wishing to become attached to these centres can do so by paying a very small sum. Besides entitling the undertaking to the results of these tests, very valuable information is given in regard to industrial appliances and their installation.

[The Author then described the Standard Method of Testing Domestic Cookers as set out by The Institution of Gas Engineers.]

The tester gives a written opinion on any new developments on the cooker, and if anything is not up to the standard of workmanship required, it is reported on the test sheet. If this is not then rectified, the cooker is not passed as being successful.

Every enamel cooker has to have an enamel cracking test.

Washboilers.

These tests are usually of a very simple and straightforward type, and do not require special apparatus.

Into the boiler is poured 80 lb. of cold water and the initial temperature is recorded. Now the boiler burner is ignited and the temperature is carefully watched until it just reaches boiling point. The consumption of gas and the time taken are again recorded, and the following result is given:

$$\frac{\text{Temperature rise} \times \text{weight of water} \times 100}{\text{Gas used} \times \text{C.V.}} = \text{Percentage thermal efficiency of washboiler.}$$

The efficiency must be over 58% or the appliance does not pass the test.

Notes are also made on the construction of the boiler and special mention is made if any constructional improvements are noticed.

Instantaneous Water Heaters.

The water is allowed to flow through the heater and the temperature is recorded. Then the burner is ignited and the final temperature of the water recorded.

Again the heater is turned off and a 2-gallon container is placed beneath the spout of the heater. The heater is once more turned on and the water is allowed to flow until the container is just full. The gas consumed and the calorific value at the time of test are taken and from these data an efficiency can again be found. This test should be carried out for varying final temperatures.

No water heater of less than 68% efficiency would be passed.

As before, notes are made on safety devices, finish, and new improvements.

Gas Fires.

The general method of test is the Leeds test. The fire is fixed at a point in the centre of a framework. Rotating about the half-way mark of this frame is a rod of ½ in. iron, bent in a semi-circle with a radius of 34·4 in. from the centre of the fire. To this iron rod is attached a radiometer or thermopile and readings are taken at 20° intervals to the left and right of the central position, and 20°, 40°, 60°, and 80° above and below. From these readings the total heat distributed to this hemisphere is found and percentage efficiency can be calculated as before.

$$\frac{\text{Total heat output} \times 100}{\text{Gas consumed} \times \text{C.V.}}$$

The efficiency of a gas fire should not be below 40%.

The attractiveness and ease of igniting and using are factors which have to be recorded and are just as necessary as the actual test when selling a fire.

Consumption tests and notes on attractiveness and utility are carried out on all small appliances or gadgets, such as gas pokers, gas pistols, &c. Tests are also carried out for lighting, &c.

Should every undertaking be fortified with the knowledge obtained from these tests, it would be a far simpler matter to ascertain which appliances would be most suited for the particular need than the present system of trial.

However, in addition to the Industrial Centres, I think much could be done if a central testing body was set up. Here the results of all the tests carried out by the Centres could be checked and a system of awards agreed upon. By this I mean that should an appliance be agreed upon unanimously by all the Centres as being almost perfect, that appliance should have an A1 award. There should not be more than five stages of awards, these to be given irrespective of price.

This would satisfy a long-awaited want of the salesmen of the Industry. They would be able to tell at a glance without having to refer to figures or literature, as to the merit of every appliance by simply looking at the class of award obtained.

This policy would also start a great wave of "cleaning-up" among appliance manufacturers. Those who manufacture inferior appliances would either have to make better appliances or close down. The remaining manufacturers who qualify their appliances for these awards would now be faced with a serious competition. If a large number of appliances were classified as being of a certain standard, the manufacturer who obtained the business would be the one with the lowest price.

Discussion.

Mr. F. S. Johns asked the Author for further particulars of the tests carried out on enamels, and also what percentage of a batch of cookers was taken for test purposes.

Mr. R. T. Mills wanted to know whether the heat losses from an oven were very much higher if, during the maintenance test, the temperature was increased by 50%.

Mr. W. J. Viney asked the Author if there was any difference in the efficiency of unloaded and loaded ovens.

Mr. R. H. Bone expressed his surprise at the low efficiency figures which were obtained from gas fires. Mr. Bone went on to say that many complaints were received from the district with regard to faulty thermostats and governors. The complaints when attended to were actually found to be ill-fitting doors.

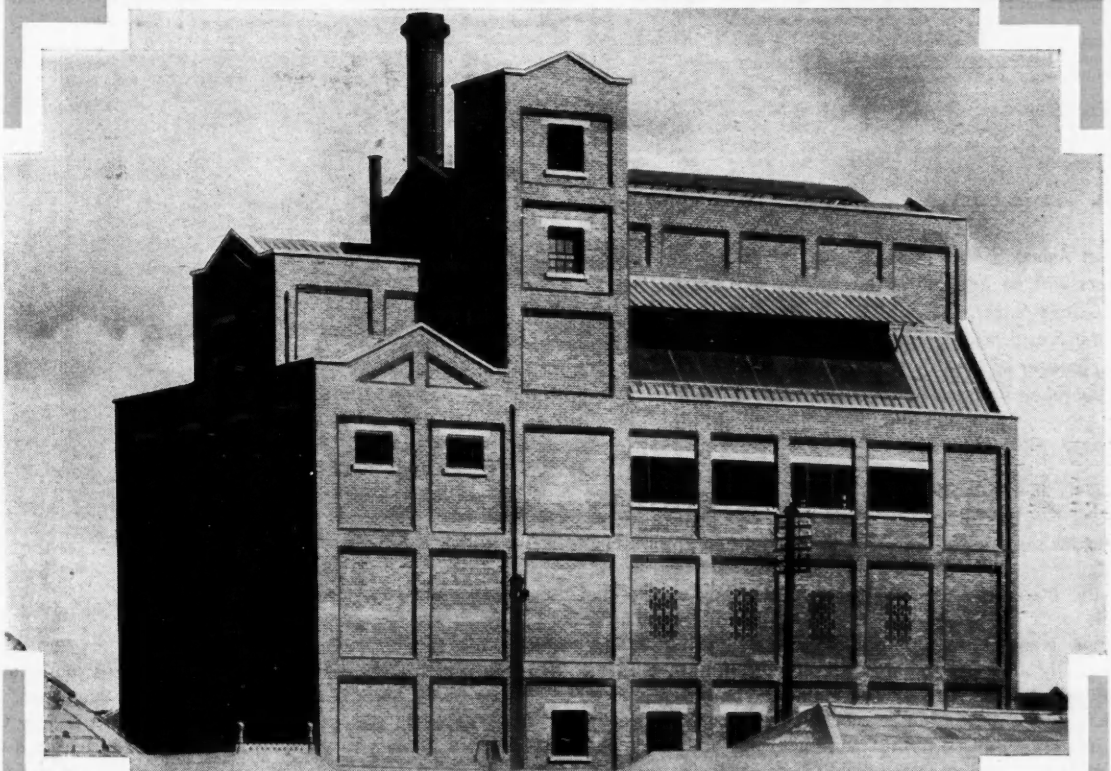
Mr. Osborne said Mr. Muir mentioned that awards should be given to appliance manufacturers irrespective of price. To him this hardly seemed fair, as the cheaper appliances could not be compared with the more expensive ones.

Others taking part in the discussion were Messrs. I. G. Jenkins, D. E. Wilkins, and H. V. Williams.

Mr. Muir said a sample cooker was usually submitted for test before any were actually ordered. Details of the enamel test were given. With regard to the efficiency of gas fires, it was not yet possible to obtain a gas fire with a radiant efficiency above 50%. The temperature of 350° F. was fixed as being the average temperature of the oven during cooking. If, however, the temperature was raised, the heat losses would also be increased.

A vote of thanks to Mr. K. E. Muir for his Paper was proposed by **Mr. R. H. Bone** and seconded by **Mr. R. Bastow.**

W-D VERTICALS



The installation at Bridgwater which is now nearing completion

Plants now under construction

W-D Continuous Vertical Retorts

	Tons of coal per day		Tons of coal per day
■ ASCOT (3rd Installation)	23	■ LOUGHBOROUGH (3rd Instn.)	17
□ BIRMINGHAM (Saltley Works)	426	□ LUTON	78
■ BRIDGWATER	61	■ NAPLES (2nd Installation)	71
■ BRIXHAM	12	■ NEWQUAY (2nd Installation)	4
■ CHESTER (2nd Installation)	66	■ NOVARA (Italy)	27
■ DONCASTER	193	■ REDDITCH	138
■ FERRARA (Italy)	33	■ RUGBY (2nd Installation)	48
■ FREMANTLE (3rd Installation)	10	■ SIDMOUTH	22
■ GRIMSBY (3rd Installation)	32	□ SMETHWICK	72
■ KENSAL GREEN (4th Installation)	371	■ WORCESTER	74

W-D Intermittent Vertical Chambers

■ PORTSMOUTH (Hilsea 2nd Instn.) 309 ■ TOTTENHAM (2nd Installation) 93

■ WESTON-SUPER-MARE (2nd Installation) 72

W-D Static Vertical Retorts

■ CAMBRIDGE 80

■ New Installation □ Complete Modernisation

THE WOODALL-DUCKHAM VERTICAL RETORT & OVEN CONSTRUCTION CO. (1920) LTD.
EBURY HOUSE, 150 VICTORIA STREET, LONDON, S.W.1

TELEPHONE: VICTORIA 8631 (6 LINES) *Members of the Society of British Gas Industries* TELEGRAMS: "RETORTICAL, SOWEST, LONDON"

T.G.S.

Annual Meeting of THE INSTITUTION OF GAS ENGINEERS

June 6 to 9

1939

The 76th Annual General Meeting of The Institution of Gas Engineers will be held at The Institution of Civil Engineers, Great George Street, London, S.W. 1, from June 6 to 9 next, under the Presidency of ROBERT ROBERTSON (Engineer and Works Manager of the Bristol Gas Company). We publish on the following page full details of the programme.

THE PRESIDENT

An Attractive Programme

THE stage is set for the 76th Annual General Meeting of The Institution of Gas Engineers, which will be held next week, under the Presidency of Mr. Robert Robertson, at the Institution of Civil Engineers, London. In this, our First Institution Number, we publish abstracts of the six Papers which are to be presented and discussed during the three days of business session, June 6, 7, and 8. The fare provided is varied, and some of the subjects to be considered are of novel interest from both the manufacturing and the sales point of view. Our pages to-day indicate that the meeting will lag behind none of those which have preceded it in profit or pleasure.

The meeting opens on a new note—presentation, without discussion, of a Symposium on the Gas Industry Overseas. It was felt that the centenary of the death of William Murdoch was an appropriate time to consider the origin and development of the Gas Industry in other countries; and the Symposium consists of a series of short articles by eminent representatives of the Gas Industry overseas. Then, following the Presidential Address, Dr. E. F. Armstrong will deliver the Murdoch Centenary Lecture.

As for the Papers, these should ensure a "packed house" at all the sessions. The first to be presented, by Mr. Grogono and Mr. Finlayson, deals with the test installation of static vertical retorts at the Croydon Gas-Works, and typifies the tradition of co-operation between gas undertaking and plant constructor. There is no doubt that the data presented, as well as the details of the methods employed in this example of large-scale commercial research work, will be of service to the Gas Industry. At the same session—on the afternoon of Tuesday—Mr. N. S. Smith will give a Paper on distribution and sales organization, specifically dealing with the activities of the Bristol Gas Company. Tuesday afternoon's session will close by a report of proposals for the conduct of co-operative research.

On Wednesday morning Dr. Moore and Mr. Liddiard, of the British Non-Ferrous Metals Research Association, will present a Paper indicating how research and development work on non-ferrous metals and alloys is widening their field of use. In common with other industries, the Gas Industry is reaping the benefit of this work as materials more suitable for particular purposes are constantly being developed. The other Paper on Wednesday is on "Comfort Heating by Gas," by Mr. Andrew and Mr. Barron, of the Gas Light and Coke Company—a contribution which considers the extent to which gas can economically provide the maximum comfort in domestic and non-domestic premises. The comparative cost of heating by gas, solid fuels, and electricity is discussed in detail in this Paper, and reference is made to technical developments in the design of a gas fire to replace the open coal fire in the living room. The adoption of attractive tariffs for gas makes it necessary to take a new outlook on the space heating load.

The first of the two Papers at the final business session on Thursday is by Mr. Croft, on the installation of tower gas purifiers at the Wandsworth Gas-Works—the first of their kind to be erected in England. Results obtained under working conditions are given in this Paper, which concludes with observations on the financial aspect of the installation. The other Paper is by Mr. Parrish. The subject is by-product ammonia, and the development of the manufacture of concentrated gas liquor in automatically controlled plants and its treatment at central chemical works are considered.

Now let us take a glance at the social events and visits which have been arranged for the interest and pleasure of both members and the ladies. The President's Reception and Dance will be held on Tuesday evening, as previously, at Grosvenor House. For Wednesday afternoon visits have been planned to the Luton Works of the Davis Gas Stove Company, Ltd., the Wembley Works of the General Electric Company, Ltd., and to Windsor Castle. The Thursday afternoon visits are to the Wandsworth Gas-Works and the Re-Distribution Station at Worcester Park of the Wandsworth Company. Friday, as usual, is devoted to a whole-day visit—on this occasion to Bristol and Weston-super-Mare.

PROGRAMME OF THE MEETING

TUESDAY, JUNE 6.

10. 0 a.m. Opening of 76th Annual General Meeting in the Great Hall of The Institution of Civil Engineers, Great George Street, London, S.W. 1.

Welcome to the representatives of Overseas Gas Associations and members from abroad.

Presentation, without Discussion, of "The Gas Industry Overseas: A Symposium." (Publication No. 204.)

Confirmation of the Minutes and adoption of Annual Report and Accounts for the year 1938. (Communication No. 205.)

Report of the Scrutineers of the Ballots.

Presentation of Medals.

10.25 a.m. Presidential Address by Robert Robertson, M.Inst.C.E., Engineer and Works Manager, Bristol Gas Company. (Communication No. 206)

11. 0 a.m. to 12. 0 noon. Murdoch Centenary Lecture, by E. F. Armstrong, D.Sc., LL.D., F.R.S. (Communication No. 207.)

12.10 p.m. to 12.20 p.m. Photograph of members and visitors attending the Meeting, to be taken on the Horse Guards Parade.

12.45 p.m. to 2.30 p.m. President's Luncheon in the Ballroom of the Savoy Hotel, Victoria Embankment, W.C. 2.

3. 0 p.m. Paper on "The Test Installation of Static Vertical Retorts at Croydon Gas-Works," by Walter Grogono, M.I.Mech.E. (Engineer, Croydon Gas Company), and T. Campbell Finlayson, M.Sc., M.I.Chem.E. (Deputy Technical Director, The Woodall-Duckham Companies, London). (Communication No. 208.)

4. 0 p.m. Paper on "Distribution and Sales Organization," by Noel S. Smith, Assoc.M.Inst.Gas E. (Distribution Engineer and Sales Manager, Bristol Gas Company). (Communication No 209)

5. 0 p.m. Report of proposals for the conduct of co-operative research.

9. 0 p.m. to 2. 0 a.m. Reception and Dance in the Great Room of Grosvenor House, Park Lane, W. 1.

WEDNESDAY, JUNE 7.

10. 0 a.m. to 11. 0 a.m. Paper on "Non-Ferrous Metals and the Gas Industry," by Harold Moore, C.B.E., D.Sc., Director, and E. A. G. Liddiard, M.A., Assistant Research Superintendent, British Non-Ferrous Metals Research Association. (Communication No. 210.)

11. 0 a.m. to 11.15 a.m. General Meeting of the Contributors to The Benevolent Fund of The Institution of Gas Engineers.

11.15 a.m. to 12.15 p.m. Paper on "Comfort by Gas Heating," by L. W. Andrew, B.A., B.Sc., and A. Barron (Gas Light and Coke Company). (Communication No. 211.)

2. 0 p.m. to 7. 0 p.m. Visit to the Luton Works of the Davis Gas Stove Company, Ltd. Ladies may participate.

or

2. 0 p.m. to 6. 0 p.m. Visit to the Osram Lamp and Glass Works of the General Electric Company, Ltd., Wembley. Ladies may participate.

1.30 p.m. to 7. 0 p.m. Ladies' visit to Windsor Castle.

THURSDAY, JUNE 8.

10. 0 a.m. Paper on "Installation of Tower Gas Purifiers," by Cyril M. Croft., M.Inst.C.E., M.I.Mech.E. (Chief Engineer and General Manager, Wandsworth and District Gas Company). (Communication No. 212).

11. 0 a.m. Paper on "By-Product Ammonia," by P. Parrish, F.I.C., M.I.Chem.E. (Manager, Phœnix Wharf Chemical Works, South Metropolitan Gas Company). (Communication No. 213.)

12. 0 noon to 12.15 p.m. Votes of thanks and presentation of Presidential Certificate to the retiring President.

12.45 p.m. Council Luncheon to the President in the River Room of the Savoy Hotel, Victoria Embankment, W.C. 2.

2. 0 p.m. to 6.15 p.m. Visit to The Wandsworth Works of the Wandsworth and District Gas Company.

or

2.30 p.m. to 6.15 p.m. The Re-Distribution Station, Worcester Park, of the Wandsworth and District Gas Company.

FRIDAY, JUNE 9.

VISIT TO BRISTOL AND WESTON-SUPER-MARE.

Morning: Paddington Station (9.25 a.m.) by Special Train to Bristol (Temple Meads) Station (11.35 a.m.).
Bristol (Temple Meads) Station (11.40 a.m.) by Motor Coach to *either*
(i) Canons Marsh Gas-Works
or
(ii) Gas Showrooms and Central Offices (Radiant House) of the Bristol Gas Company,
terminating at the Victoria Rooms (12.50 p.m.).
Luncheon, by invitation of the Chairman and Directors of the Bristol Gas Company, in the Victoria Rooms, Bristol.

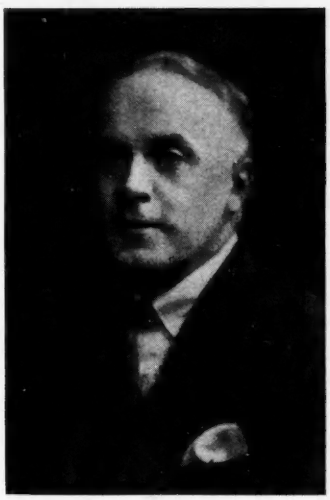
Afternoon: Victoria Rooms (2.30 p.m.) by Motor Coach, *via* Durdham Downs, Clifton Suspension Bridge, Belmont Hill, Flax Bourton, and Conglesbury, to the Winter Gardens Pavilion, Weston-super-Mare (4 p.m.), where music will be provided by the Weston-super-Mare Municipal Orchestra (Leader: Mozart Allen).
Tea at the Winter Gardens Pavilion (4.30 p.m.).

Evening: Winter Gardens Pavilion (5.15 p.m.) by Motor Coach to Weston-super-Mare (General) Station (5.20 p.m.).
Special Train, which will call at Bristol (Temple Meads) Station at 6 p.m., and on which supper will be served, to Paddington Station (8.25 p.m.).

It is essential that each participant in the whole of the visit to Bristol and Weston-super-Mare should be provided with a Railway Ticket, and five Admission Tickets, although the arrangements permit of the issue of Tickets omitting the Special Train journey and/or the Visits, Luncheon, Tea, and Supper.

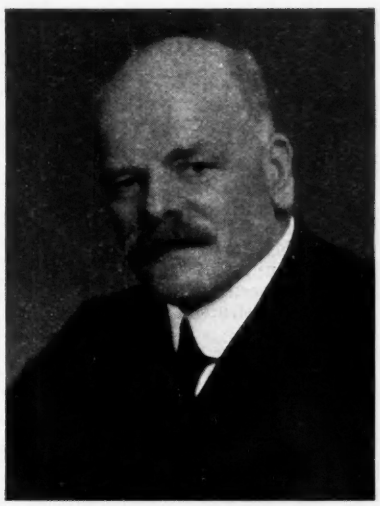
The Railway Ticket will entitle the holder to travel by the Special Train, or any Ordinary Train to and from Bristol or from Weston-super-Mare, on the Friday. The Ticket may be converted to a Monthly Return Ticket on payment of a supplement of 8s. 6d. at Bristol (Temple Meads) Station or 10s. 8d. at Weston-super-Mare (General) Station.

THE SENIOR VICE-PRESIDENT.



G. Dixon.

THE JUNIOR VICE-PRESIDENT.



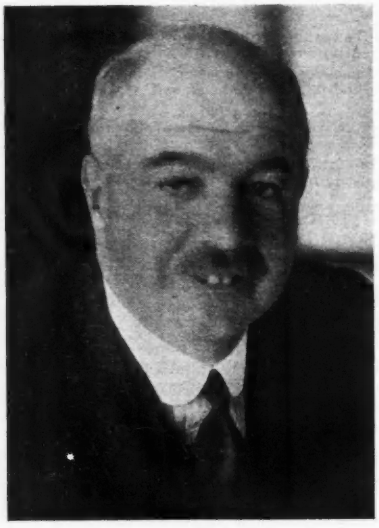
Sir Frederick West.

THE SECRETARY.

W. T. K. Braunholtz.

THE INSTITUTION AUTHORS

With Summaries of their Technical Communications



WALTER GROGONO.

Educated at Epsom College, Mr. Grogono became a pupil of the late Mr. John Clark, of the West Ham Gas Company in 1904. He was appointed an Assistant Engineer to the Gas Light and Coke Company when they amalgamated with the West Ham Gas Company in 1910, and served in that capacity at Stratford, Beckton, Bromley, and Fulham. In 1927 he was appointed Engineer to the Croydon Gas Company, the post he now occupies. Mr. Grogono was President of the London and Southern District Junior Gas Association in 1924 and has also been a recipient of the Institution Silver Medal.

The Test Installation of Static Vertical Retorts at Croydon Gas-Works

by

WALTER GROGONO, M.I.Mech.E., M.Inst.Gas E.,
Engineer, Croydon Gas Company,

and

T. CAMPBELL FINLAYSON, M.Sc., M.Inst.Gas E., M.I.Chem.E.
Deputy Technical Director, The Woodall-Duckham Companies, London

Communication No. 208

The Paper describes three years' work on an experimental carbonizing plant erected at Croydon Gas Works.

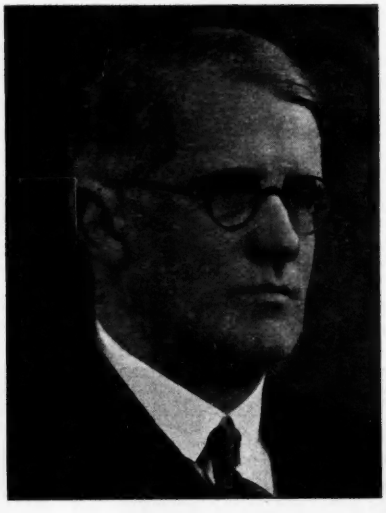
The evolution of the static vertical retort is explained in the introductory section. The basic idea underlying this development was that if the advantages of the intermittent vertical chamber process could be associated with the advantages of the continuous vertical retort process as regards the extraction of cool coke and continuous steaming, then an improvement in carbonizing technique should result. A new form of plant embodying these combined principles was therefore designed and an arrangement reached whereby it was possible to erect a test installation at Croydon.

The test plant was designed to prove whether the proposed process of carbonization would work satisfactorily, to determine whether the proposed methods of construction were likely to offer any difficulties on a commercial scale, and to ascertain yields of products when carbonizing various coals, with a sufficient degree of accuracy to enable a comparison to be made between the static vertical retort and other forms of carbonizing plant. The results presented in this Paper must be viewed in the light of the above considerations.

A Section is devoted to a description of the static vertical retort, from the point of view of both principles of construction and principles of operation.

In the fourth section of the Paper the test plant as erected at Croydon is described in detail and is illustrated by sketches and photographs. The test plant comprises one static vertical retort, complete with coal and coke handling plant, a step-grate producer and gas treatment plant for the recovery and accurate measurement of the various gaseous and liquid products of carbonization.

The experimental work carried out during 1936, 1937 and 1938 is described in Section V. It is recorded that at the conclusion of the testing programme the retort had carbonized 2,800 tons of coal, of which 2,000 tons were Durham Run-of-Mine coals. The retort had been under heat for 670 days. From the commencement of operation to the shutting down of the plant at the conclusion of the testing programme, no alterations or repairs to the static vertical retort were required. The methods employed in determining the yields of products of carbonization are also detailed in this section. Attention is drawn to the fact that all gas making results are corrected to allow for the addition of 3 per cent. air for purification, in order to bring the results into conformity with normal Works practice. The data obtained are summarized in a series of tables covering gas making results on



T. CAMPBELL FINLAYSON.

Mr. T. Campbell Finlayson was educated at Manchester Grammar School and Manchester University, where he graduated B.Sc. (Hons.) and subsequently obtained his M.Sc. From 1915 to 1919 he was employed by the Department of Explosives Supply of the Ministry of Munitions in various factories producing T.N.T., phosgene, &c. In 1921 he joined the staff of the Woodall-Duckham Companies for research on methods of producing oxygen, and since 1923 he has been engaged on the design and development side of the Companies, having been responsible during the last seven years for the co-ordination of the Companies' design practice. The position he at present holds with the firm is that of Deputy Technical Director.

various coals, yields of coke, liquor and tar, volumetric gas analyses, and yields of gaseous constituents per ton of coal.

A discussion of the results obtained and a comparison with known results of other methods of carbonization are presented in Section VI. The relationship between the thermal yield per ton of coal and the calorific value of the gas is graphically represented by a series of "steaming curves" for different coals.

On the coals tested the static vertical retort appears to give a higher thermal yield than either intermittent vertical chambers or continuous vertical retorts. As the calorific value falls, the advantage of the static vertical retort in this respect generally increases. Consideration is given to such matters as the range of calorific values of gas obtainable from the static vertical retort, the control of calorific value of gas, and the rate of carbonization. Curves are included showing the rate of production of total gas and of constituent gases during the carbonization of a typical charge of Durham coal. The quality of tar made from different coals when carbonized in the static vertical retort has been the subject of laboratory investigation and is discussed in detail. Broadly speaking, the properties of static vertical retort tars are intermediate between those of tars produced in coke ovens and in continuous vertical retorts.

The yield, grading, and characteristics of the coke made from different coals are also dealt with. The density of the coke is intermediate between that of coke made in intermittent vertical chambers and that of coke made in continuous vertical retorts. The characteristics of static vertical retort coke in an open vertical bar grate have been examined by means of a series of tests carried out at the Fuel Research Station, details of which tests are included by permission. From these tests on a variety of coke samples made from different coals and carbonized in different types of plant the broad conclusion is reached that the influence of the type of coal is greater than the influence of the type of plant.

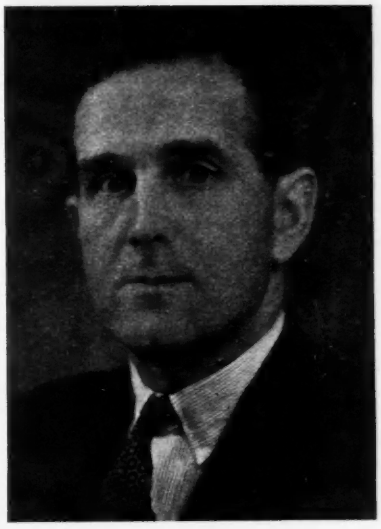
Communication No. 209

Distribution and Sales Organization

by

NOEL S. SMITH, Assoc.M.Inst.Gas E.,
Distribution Engineer and Sales Manager, Bristol Gas Company

Mr. Noel S. Smith is a native of Burton-on-Trent and served five years' apprenticeship in gas manufacture at Swadlincote before taking up the supply side. Since 1919 he has been successively in charge of distribution and sales at Greenock, Luton (1925 to 1932), and Bristol. Mr. Smith holds a First-Class Certificate in Gas Supply of the City and Guilds of London Institute and is a past-Chairman of the Scottish Salesmen's Circle.



NOEL S. SMITH.

This Paper deals specially with the distribution and sales activities of the Bristol Gas Company.

The principal features of control, policy, organization and work routine, although abbreviated, are each described. The duties and responsibilities of distribution management, which are clearly defined, are set out.

In general, the Paper describes the system of operations and as far as possible indicates results by means of figures.

A feature of the Paper is the description of the extent to which co-operation has been developed between other public utilities, builders and allied traders.

Particulars and costs are given of a system of transport by contract.

Communication No. 212

CYRIL M. CROFT.

Installation of Tower Gas Purifiers

by

CYRIL M. CROFT, M.Inst.C.E., M.I.Mech.E.,
Chief Engineer and General Manager, Wandsworth and District Gas Company.

Mr. Croft served his pupilage under Mr. H. E. Jones and Mr. F. H. Jones, past and present Chairman of the Wandsworth and District Gas Company, commencing his active association with the Gas Industry in 1908. After short service with the Commercial Gas Company as Assistant District Engineer, he was appointed to the position of Works Manager of the Wandsworth and Putney Gas Company. On the formation of the Wandsworth, Wimbledon, and Epsom District Gas Company he was appointed Assistant Engineer to the amalgamated Company. Eight years later he became Chief Engineer of the Company, being appointed ten years afterwards to his present position of Chief Engineer and General Manager. Mr. Croft is a Justice of the Peace for the Wandsworth Division of the County of Surrey.

This Paper describes the installation of tower gas purifiers—the first of their kind to be erected in England—at the Wandsworth Works of the Wandsworth and District Gas Company. The considerations which influenced the adoption of this type of plant, as compared with the more conventional rectangular cast iron boxes, are examined and a description is given of the plant eventually installed, followed by some notes on the results obtained.

Section VI is devoted to an account of the supervision required during operation and the Paper concludes with some observations on the financial aspect of the installation.

HAROLD MOORE.

Dr. H. Moore, C.B.E., has been a Director of the British Non-Ferrous Metals Research Association since 1932; previously as Director of Metallurgical Research at the research department at Woolwich he had been engaged on work in connexion with the use of metals by all the fighting services, for many years, including the war period 1914-1918. In earlier years he had had experience in the Iron and Steel Industry, and was President of the Institute of Metals from 1934-1936. He is also the Author of a number of Papers on metallurgical and allied subjects, published by the Iron and Steel Institute, the Institute of Metals, the Faraday Society, and other scientific institutions. He has served on the Aeronautical Research Committee and several of its Sub-Committees, on numerous British Standards Institution Committees, and is at present Chairman of the Non-Ferrous Industry Committee of the British Standards Institution. The work of the British Non-Ferrous Metals Research Association is concerned with the industrial applications of all the non-ferrous metals.

Non-Ferrous Metals and the Gas Industry

by

HAROLD MOORE, C.B.E., D.Sc.,

Director,

and

E. A. G. LIDDIARD, M.A.,

Assistant Research Superintendent, British Non-Ferrous Metals Research Association

Communication No. 210

Some 90 per cent. by weight of the world's production of metals is iron or ferro-alloy. The high strength and relative cheapness of various types of steel and cast iron make them suitable for most forms of construction. Non-ferrous metals and alloys are commonly used only in those applications where iron or steel fail (*e.g.*, by corrosion) or as protective coatings for steel. The non-ferrous metals most useful industrially, aluminium, copper, lead, nickel, tin and zinc, have a greater resistance than iron to corrosion, particularly atmospheric corrosion, and retain a more attractive appearance. They are easily worked and fabricated, though sometimes by methods that differ markedly from those used for iron and steel.

Apart from corrosion-resistance, the individual non-ferrous metals have characteristics favouring their use in particular applications in the Gas Industry, especially in gas distribution and consumption. For example, aluminium, with its high reflectivity and resistance to tarnish, is used as a reflector in some types of gas fires and lights and, in the form of paint, serves to preserve constant temperature conditions in gasholders. Copper is readily fabricated and bent, has a high thermal conductivity and is easily tinned. It therefore finds application in the form of pipes, which can readily be bent or jointed, for the distribution of gas. Copper, tinned on the outside where it comes into contact with burnt gas, is extensively used in the construction of gas water heaters. Lead is chiefly remarkable for its ease of working, in addition to its exceptional resistance to certain forms of corrosion. Lead pipes supplied in coil form to minimize jointing are useful for gas distribution, particularly where the installation of pipes is complicated and difficult. Nickel, when associated with chromium as an alloying element in iron, forms a useful series of heat- and corrosion-resisting alloys, and is the best undercoating for chromium-plated articles. The low melting point of tin makes it useful as a coating metal or, when alloyed with lead in the form of solder, as a jointing material. Zinc-base alloys can be readily and cheaply die cast to form parts of gas meters, but the main use of zinc is as a corrosion-resisting coating to iron and steel.

E. A. G. LIDDIARD.

Mr. E. A. G. Liddiard was born in 1903 and educated at Christ's Hospital, and Gonville and Caius College, Cambridge. From 1922 to 1925 he was laboratory assistant at the Cyclops Works, Sheffield, of Messrs. Cammell Laird & Co., later joining I.C.I. (Fertilizer and Synthetic Products), Ltd., Billingham, as Research Metallurgist. In 1932 he became Assistant Development Officer to the British Non-Ferrous Metals Research Association, being appointed Assistant Research Superintendent in 1937.

Research and development work on non-ferrous metals and alloys is widening their field of use and, in common with other industries, the Gas Industry is reaping the benefit of this work as materials more suitable for particular purposes are constantly being discovered.

L. W. ANDREW.

Comfort Heating by Gas

by

L. W. ANDREW, B.A., B.Sc., M.Inst.Gas E.,

and

A. BARRON,

The Gas Light and Coke Company

Communication No. 211

Mr. L. W. Andrew was educated at Nuneaton Grammar School and Oriel College, Oxford. He obtained First-Class Honours in Natural Science in 1928, in which year he was appointed a Research Chemist to the Gas Light and Coke Company at Watson House, where he is now in charge of the Space Heating Laboratory.

This Paper is an attempt to consider the extent to which gas can economically provide the maximum comfort in domestic and non-domestic premises.

Section III deals with comfort. A distinction is made between warmth and the more complicated factors which give the highest degree of comfort.

The fourth Section deals with domestic space heating and first considers recent technical developments of appliances. The comparative cost of heating by gas, solid fuels, and electricity is discussed in detail, with special reference to the open coal fire in the living room.

An estimate is given of the annual cost of providing varying degrees of comfort by different methods. It is shown that if the heating of a house is considered as a whole it is possible, if gas can be purchased on the two-part tariff, to provide an unusually high standard of comfort in an all-gas house at a very reasonable cost. If gas is more expensive the present comfort standard in a home can be much improved at a low cost or even at a reduced cost.

It is particularly important to consider the replacement of the living room coal fire by a gas fire, the use of background heating in the hall and living room, and the use of flueless fires during mild weather.

The estimates of cost given are mainly theoretical, but practical data are given on a series of tests in rooms heated throughout the winter of 1938-39 by coal, coke, and gas fires.

A part of the final Section deals with the future of gas for domestic heating. The immense potential load is discussed and desirable technical developments of appliances to assist in obtaining it; in particular, the design of a gas fire to replace the open coal fire.

Central heating by hot water is dealt with briefly in Section V and tables of estimated and actual costs are provided for specific situations. A short explanation is given of the method used for estimating gas and coke consumptions for all situations.

Section VI deals with non-domestic premises. Different methods for heating offices are described and intermittent heating discussed. The complications involved in the heating of factories really require far more space than that available. Heating by air, with or without complete conditioning, is mentioned, and probable situations are described.

The direct use of gas by unit heaters and radiant panels has great possibilities, particularly in industrial situations,

A. BARRON.

Mr. A. Barron was educated privately and at Oundle School. In July, 1927, he entered the service of the Gas Light and Coke Company as a staff pupil. After a five years' course of training in all departments of the Distribution and Gas Sales, he joined the Special Service Section of the Gas Sales Department, specializing in central heating and central hot water installations. In 1938, the Technical Advisory Section was formed to collect data on all heating problems and to act as consultants to the Company's salesmen. Further, the Section, to which Mr. Barron was appointed, maintains close contact with the heating trade, consulting engineers, and architects.

and the tables of capital costs and running costs show that conditions are very favourable to a large load increase for the Gas Industry in this direction.

It is hoped that more actual data will be available in the near future.

P. PARRISH.

By-Product Ammonia

Development of the Manufacture of Concentrated Gas Liquor in Automatically-Controlled Plants and its Treatment at Central Chemical Works

by

P. PARRISH, M.Inst.GasE., F.I.C., M.I.Chem.E.

Manager, Phœnix Wharf Chemical Works, South Metropolitan Gas Company

Communication No. 213

Mr. P. Parrish was trained at the works of J. Brown & Co., Ltd., Tar Distillers and Chemical Manufacturers, becoming Manager and later General Manager (1910-1914). He was subsequently appointed General Manager of the Egglescliffe Chemical Company, Ltd., Co. Durham. He joined the South Metropolitan Gas Company in 1915 as Manager of the Chemical Works. Mr. Parrish is the Author of several books, and was an original member of the Yorkshire Junior Gas Association. He has contributed several papers to various technical societies.

In this Paper an attempt is made to examine the methods of treatment of by-product ammonia and the sale of sulphate of ammonia, during the last forty years; to determine what has been the impact of processes for the manufacture of synthetic ammonia and its products, and to forecast how a sensibly improved revenue can be obained from by-product ammonia in the future.

Twenty years ago the revenue derived by the three metropolitan Gas Companies from the manufacture of sulphate of ammonia and ammoniacal liquor was equivalent to a contribution of 2s. 9d. per ton of coal carbonized.

With the advent and development of the manufacture of synthetic ammonia, and its conversion to ammonium products at various continental and British factories, there was a notable over-production, with the result that the accounts of the three Companies showed a deficit, in 1932, equivalent to 0·48d. per ton of coal carbonized.

Obviously, this called for the examination of the conditions under which sulphate of ammonia was being produced at that time. It was found that from an economic viewpoint the units of production were small, and, moreover, that it was wrong in principle to distil weak gas liquor, involving appreciable expense on steam for the recovery of the ammonia. Attention was naturally directed to processes by which gas liquor could be concentrated, with a minimum steam consumption, and independent of labour, in order that Gas Works within a suitable geographical area could despatch concentrated gas liquor to a central works for treatment.

This led to the development of automatic processes for the concentration of gas liquor. This Paper deals with the evolution of such processes, and reveals that it is not prudent to limit selection to one type of plant for all the varying qualities of gas liquor produced. Evidence exists that the vapour phase process, *i.e.*, partial decarbonation at a selected part of the condenser, is the most economical, and indeed the most flexible, in that it more nearly fulfils the varying requirements demanded.

It has now been demonstrated that concentrated gas liquor in relatively large plants, and, indeed, in many moderate-sized ones, can be produced for 5d. to 6d. per unit of ammonia, all costs included. In 1929, prior to the intensive campaign to evolve automatic processes, the cost of production was 1s. 3d. to 1s. 6d. per unit of ammonia.

The economic treatment of concentrated gas liquor is best undertaken at an existing chemical works, geographically well-situated, and having a sulphuric acid plant of flexible capacity. How these central schemes can be established, to the mutual advantage of Gas Undertakings and the chemical works, is defined. One such scheme has been responsible for a substantial annual saving to the Gas Undertakings which are constituent members.

Concentrated gas liquor can be utilized at central chemical works, not only in the production of ammonium sulphate, but of other important nitrogenous fertilizers. Indeed, it can be converted to nitric acid, and ammonium nitrate produced, or it can be absorbed by phosphoric acid, in the manufacture of mono-ammonium or di-ammonium phosphate.

The possibilities in this direction are briefly outlined, and it is suggested that this branch of the fertilizer industry is one that is calculated in certain circumstances to be more lucrative than the production and sale of sulphate of ammonia.

The Murdoch Centenary Lecture

This year marks the centenary of the death of William Murdoch, and an interesting feature of the Institution programme will be the Murdoch Centenary Lecture, which will be delivered by Dr. E. F. Armstrong at the opening session on the morning of Tuesday, June 6.

E. F. ARMSTRONG, D.Sc., LL.D., F.R.S.

Dr. E. F. Armstrong studied chemistry in London, Kiel, Berlin, and Copenhagen, subsequently spending eight years with Messrs. Huntley & Palmers, Ltd., Reading. Other appointments included Managing Director of William Gossage & Sons, Ltd., of Joseph Crosfield & Sons, and other soap and chemical manufacturers, and later Managing Director of British Dyestuffs, Ltd. He came to London as a Consulting Chemical Engineer in 1928. He is best known in the Gas Industry as a Director of the South Metropolitan, South Suburban, and Commercial Gas Companies, while he is also Governor of the Imperial College of Science and Treasurer of the Royal Society of Arts.

THE PAPERS TO BE PRESENTED

Six Papers are to be presented at the Institution Meeting next week. Two of these—with the exception of a few diagrams—we publish in full in the following pages. These are Communications Nos. 210 and 212. The other Papers are abridged. The Communications are issued as Institution "blue books," and are obtainable on application to the Secretary, Dr. W. T. K. Braunholtz. A full report of the Discussions on the Papers will appear in our Second Institution Number on June 14.

The Test Installation of Static Vertical Retorts at Croydon Gas Works

Communication No. 208

[Abstract]

by

WALTER GROGONO, M.I.Mech.E., M.Inst.Gas E.

(Engineer, Croydon Gas Company),

and

T. CAMPBELL FINLAYSON, M.Sc., M.Inst.Gas E., M.I.Chem.E.

(Deputy Technical Director, The Woodall-Duckham Companies, London).

INTRODUCTION

Thirty-one years ago a Paper was presented to The Institution of Gas Engineers by the Engineer and General Manager of the Bournemouth Gas and Water Company,[1] describing the experimental work carried out on the first test installation of continuous vertical retorts, facilities for the experimental work having been provided at his Works. The modern continuous vertical retort, as built by various constructional firms today, is far in advance of the early efforts of 1908. The rapid development in application and design, however, may well have been helped by the early publication to the Gas Industry of the experimental results obtained in the first test installation.

Following this tradition of co-operation between Gas Undertaking and plant constructor—to their mutual benefit—the present Paper describes three years' work on an experimental carbonizing plant erected at Croydon Gas Works. The designer of today is fortunate in being able to avail himself of a great accumulation of experience in the principles of coal carbonization and the methods of plant construction. Nevertheless it may well be that the static vertical retort, described in this Paper, will go through a process of evolution in its commercial form. Consequently the information must be regarded as being in the nature of an "interim report", but the Authors trust that the data presented, as well as the details of the methods employed in this example of large-scale commercial research work, may be of interest and service to the Gas Industry.

The evolution of the static vertical retort may be considered to start with the filing of a patent by the late Sir Arthur Duckham in June, 1930.[2] The patent describes "an intermittently operated two-stage vertical carbonizing retort divided into two or more superposed portions, the upper of which forms a coal carbonizing zone and is externally heated, whilst the lower portion or portions forms or form a zone or zones in which water gas is produced and in which the coke is to a certain extent cooled." This patent was filed at a time when intermittent vertical chambers were attracting a considerable amount of interest in Great Britain.

During the period from 1930 to 1935 a number of installations of intermittent vertical chambers were built in this country by various constructional firms. In one particular direction intermittent vertical chambers gave room for improvement, and that was in the quenching of the coke by water. Not only did this give rise to large volumes of dust-laden steam, which in certain cases created a nuisance, but also it led to an unnecessary loss of heat. Alternative means of effecting coke cooling naturally came under consideration. Further, during recent years much attention has been directed to the possibilities of improving the yield of gas from the carbonization of coal by what has generally become recognized as the controlled cracking of hydrocarbons in the presence of hydrogen.

It was realized that, if the advantages of the intermittent vertical chamber process could be associated with the advantages of the continuous vertical retort process as regards the extraction of cool coke and continuous steaming, an improvement in technique would result. These combined factors led the Woodall-Duckham Company in 1934 to design a new form of carbonizing plant which embodied the essential features of Sir Arthur Duckham's 1930 patent.

The design seemed to offer sufficient promise of success to justify the erection of a full-scale test plant to explore the possibilities of the new process. Accordingly an arrangement was reached, through the courtesy of the Directors of the Croydon Gas Company, whereby it was possible to erect the test installation at the Waddon Works.

The present Paper gives an account of the work carried out at Croydon during the period from 20th April, 1936, when the plant was put to work, to 21st October, 1938, when it was shut down at the completion of the experimental programme. During the whole of this period all the manual operations were carried out by retort house employees of the Croydon Gas Company as part of their normal duties. Shift supervising staff was provided by the Woodall-Duckham Company. Thus, from the commencement, the plant was treated as a normal carbonizing unit, subject to normal attention.

The test plant was designed with the following objects in view:

(i) To prove whether the proposed process of carbonization would work satisfactorily, and to ascertain by experience the best methods of operation.

(ii.) To determine whether the proposed methods of construction were likely to offer any difficulties on a commercial scale.

(iii) To ascertain yields of products when carbonizing various coals, with a sufficient degree of accuracy to enable a comparison to be made between the static vertical retort and other forms of carbonizing plant.

The results presented in this Paper must be viewed in the light of the above considerations. It is not claimed that anything fundamental has been added to scientific knowledge.

[1] Woodall, H. W., *Trans. Inst. Gas Eng.*, 1908, p. 97.
[2] British Patent No. 357,146.

It was only by following the main road to the supply of the essential information for the building of a full-scale commercial unit and leaving on one side the interesting by-paths to more fundamental research that it was possible to bring the programme of work to its present stage in two and a-half years. Even so, over four years have elapsed from the date of the preparation of the first sketch of the static vertical retort as built at Croydon to the putting to work of the first commercial unit.

DESCRIPTION OF THE STATIC VERTICAL RETORT

The static vertical retort consists fundamentally of an intermittently operated two-stage vertical carbonizing retort divided into two superposed portions, the upper of which forms a coal carbonizing zone and is heated by means of external flues, while the lower portion forms a zone in which the coke is to a certain extent cooled.

Two factors effect the cooling of the coke. The first is steam which is introduced into the cooling chamber. The steam becomes superheated and, as it ascends in contact with the hot coke, gives rise to the formation of water gas. The water gas and uncracked steam in turn ascend through the carbonizing zone, in which coal gas is being evolved. The water gas and coal gas thus become intimately mixed. The second cooling factor is the transfer of heat from the cooling chamber to the surrounding atmosphere.

In practice, the upper portion consists of a vertical retort, rectangular in plan, built of silica for the whole height of the heating flues, having at the top a short belt of fireclay in which are incorporated the charging holes, and having at the bottom a short belt of fireclay. The heating flues on each side of the retort consist of a number of horizontal passages arranged one above the other, containing suitable fixed baffles and communicating with each other by means of adjustable ports through which the heating gases pass in an upward direction. All the producer gas and some of the secondary air are admitted at the bottom, the remaining air for completion of combustion being admitted at either or both of two higher levels. A separate means of control is provided for each point of admission of producer gas and secondary air, so that the temperature gradient from bottom to top of each retort side wall can be controlled as desired.

The whole of the upper portion of the retort is supported by floor joists on which rests a firebrick-lined seating casting, suspended from which is a vertical steel-cased firebrick-lined chamber. The seating casting is cooled by ducts through which passes the air for the combustion system. The seating casting and the steel-cased chamber together comprise the coke-cooling zone and, like the carbonizing portion of the retort, are rectangular in plan.

Special means of construction are adopted to prevent distortion of the casing of the coke cooling chamber and to ensure stability of its firebrick lining, while making adequate provision for expansion of the lining in relation to the casing. The cooling chamber is provided at each of three levels with two points of steam admission on each side. In practice, steam is usually admitted at only two of these three levels.

Beneath the coke cooling chamber, and carried independently, is a cast iron box containing a coke extracting device, this device being situated along the horizontal lower edge of a curved plate which forms the back of the extractor box.[3] This curved plate is provided with inspection and probing holes and with a covered manhole giving access to the extractor and to the cooling chamber above.

The weight of the charge is taken partly by the curved plate and partly by the extractor roller. The latter consists of a series of cast iron stars mounted on a horizontal shaft of square section. Each star to right and left of a centre bearing for the shaft has a slight lead on its neighbour, so that in effect a helix is formed for each half of the extractor. This ensures uniform extraction throughout each revolution of the roller, which, as it rotates, does not shear the coke but merely removes a definite amount from the skirt of the mass, the production of breeze being thereby minimized.

Cast iron swinging hangers having an adjustable stop-bar are suspended from a shaft above the extractor roller and prevent an unregulated amount of coke passing over the extractor.

At the bottom of the extractor box, *i.e.*, just below the level of the extractor roller, is a hinged discharge door occupying the whole major axis length of the cooling chamber and extractor. A gas-tight expansion joint is provided between the extractor box casting and the bottom of the cooling chamber, the latter being free to expand or contract vertically in relation to the fixed extractor box.[4]

Beneath the discharge door is a coke container, fitted internally with readily accessible hinged plates whereby its capacity can be adjusted as desired. This container is used as a measuring vessel to control the amount of coke extracted and, in a commercial plant, can be made to travel from end to end of the bench.[5]

In normal operation the retort carbonizes a fresh charge of coal every 8 to 10 hr. and, while the charge is being carbonized, steam is admitted to the cooling chamber in quantity at least sufficient to cool the coke down to an average temperature of 400° C. before it is discharged. A minimum of about 8 per cent. steam by weight on coal is used for this purpose.

When carbonization of the charge is complete, the steam is turned off, a valve in the gas offtake at the retort top is closed, the retort top lids are removed, the discharge door is opened, and a small amount of coke (sufficient to lower the charge about 3 ft.) is first extracted. By means of the retort charging car, the top of the hot carbonized charge, which remains an unbroken column until it reaches the extractor, is then covered from end to end with a layer of unscreened coke, to prevent small coal from subsequently slipping down into the cooling chamber. Coke extraction is then restarted, the extractor roller rotating at about 6 rev. per min., and continued until the previously described measuring vessel is full. The process of actual extraction does not exceed one minute. The measuring vessel can be adjusted so that, after extraction is completed, the top of the hot coke from the last charge carbonized remains at any desired level in the carbonizing zone. In this connexion, it has been found advantageous to leave at least 2 ft. depth of coke, *i.e.*, about 1 ft. of hot coke and about 1 ft. of "pad" coke, above the floor level of the lowest combustion flue.

After the introduction of the coke pad and completion of coke extraction, which together take about 2 min., the discharge door is closed and the retort is left open at the top for about 10 min. This allows air to circulate in the retort and burn off an appreciable proportion of the freshly deposited scurf, and also allows the coke pad to become red-hot before charging—a condition which has been found advantageous in the case of highly-swelling Durham coals, since, in conjunction with early steaming, it reduces the likelihood of prolonged bottom pressure being set up.[6] The retort is then charged with coal up to the top of the carbonizing zone by means of a charging car, the retort top lids are replaced, and the offtake valve is opened.

Introduction of steam to the cooling chamber is usually commenced between one-quarter and three-quarters of an hour after charging, and is continued until the next discharge. Under certain conditions it is found advantageous to increase the rate of steaming during the last hour or two of the cycle.

The above cycle of operations is repeated every 8 to 10 hr., according to the type of coal being carbonized.

By increasing the depth of residual hot coke left in the heated portion of the retort prior to refilling with coal, and by suitably raising the rate of steam admission, the coal throughput per day and the calorific value of the gas can be reduced and the thermal yield per ton of coal increased without prolonging the carbonizing time per charge and without reduction of volumetric gas output.[7]

DESCRIPTION OF THE CROYDON TEST PLANT

The test plant comprises one static vertical retort complete with coal- and coke-handling plant, a step-grate producer, and gas treatment plant for the recovery and measurement of the various products of carbonization.

The retort is supplied with producer gas from its own

[3] British Patent No. 458,857.

[4] British Patent No. 459,950.
[5] British Patent No. 474,792.
[6] British Patent No. 501,393.
[7] British Patent No. 501,394.

step-grate producer, the latter being supplied with coke from the Works. This coke is not weighed, since a knowledge of the fuel consumption for a single isolated retort would be of practically no assistance in estimating the fuel consumption for a battery of such retorts. There are, however, full facilities for weighing separately all coal and coke supplied to, and all coke discharged from, the retort, the plant having its own certified weighbridge, its own skip for coal, and separate overhead coal and coke supply hoppers.

All coal to the plant has to pass first through a 3 in. grid and then up a readily accessible inclined belt conveyor on its way to a weighbridge. Accurate weighing and sampling of coal are thus obtained. The coal is then conveyed by skip and telpher to overhead coal storage hoppers of small capacity, these hoppers being completely emptied at the end of each test, thus eliminating all calculations due to coal stocks.

All coke discharged from the retort has to pass up an inclined drag bar conveyor on its way to the weighbridge skip, and coke samples can be taken from the top of this conveyor, which can be started and stopped from a position nearby. Thus all coke is weighed and sampled accurately.

The gas treatment plant was designed to deal with an hourly gas make of up to 7,000 cu.ft. (reckoned at atmospheric temperature) and comprises successively a vertical water-tube condenser, a steam-engine driven three-stage gas fan exhauster with a by-pass governor, a Livesey washer supplied with liquor, a steam-engine driven rotary brush scrubber-washer supplied with water, and a standard station type wet meter (with stainless steel drum) to which is geared a small wet meter for taking gas samples correctly proportioned to each cu.ft. of gas made.

Gas pressure regulators are provided for maintaining a constant pressure of about 0·1 in. w.g. in the retort gas collecting main, and for maintaining a constant back pressure of about 5 in. w.g. on the two meter outlets. A device is provided for preventing gas from blowing the seal of the sampling meter in the event of any sudden rise of inlet pressure.

For dealing with the proportional gas sample from each charge of coal carbonized, there are two 20-cu.ft. gas sample holders, from which the gas can be tested in the crude state for H_2S, and from which the gas can be passed via either of two purifiers to a Boys standard calorimeter; the calorimeter is housed in a testing room which can be maintained devoid of draughts and at a constant temperature. In this testing room is also a Sigma B.Th.U. recorder for recording continuously the calorific value of the gas produced from each charge. This recorder is supplied, via either of two small purifiers, from the outlet side of the station meter. The purpose of this recorder is to indicate changes in calorific value. No gas yields are calculated from the continuous charts.

The relative sizes and gearing of the meters are such that the gas sample collected in either holder consists of 18 cu.ft. per 40,000 cu.ft. of gas made (or *pro rata*), the latter being the maximum volume usually obtained from one charge of coal. The volume of gas collected in each holder is always sufficient to permit three Boys calorimeter tests under steady conditions and two H_2S tests, together with the collection of a small sample for volumetric analysis.

While the retort is being discharged, a valve in the uptake from the collecting main is kept closed, to prevent ingress of air, and the valve of the pressure regulator at the station meter outlet remains closed automatically. Under these conditions, contraction of gas could take place in the condenser by cooling and a seal might be sucked. To avoid any possibility of such an occurrence, a small amount of 500 B.Th.U. town gas is supplied to the condenser inlet, via a separate meter, while the retort is temporarily idle. The amount supplied in this way varies from 100 to 200 cu.ft. per 40,000 cu.ft. of gas made, and full volumetric deduction is made of this amount, the effect of which on the calorific value of the gas sample is less than 0·25 B.Th.U. even when making gas differing from the town gas by 50 B.Th.U.

The plant has a completely self-contained liquor circulating system; a tar and liquor separating tank, into which flows all tar and liquor from all sources except from the rotary scrubber; two large calibrated measuring tanks for tar and liquor, provided with means for sampling at their outlets; a small tar tank and a small liquor tank above, for use while measuring and sampling from the large tanks; and a calibrated feed tank for measuring the amount of water supplied to the scrubber, the liquor from the latter flowing down into the liquor-measuring tank system.

The liquor supply for the Livesey washer is taken, via a cooler, from the circulating system on the pressure side of the pump, which also supplies a spray in the retort gas offtake and sprays in the gas main leading from the collecting main to the condenser.

A Kent steam-meter with a counter is fitted on the service to the coke cooling chamber. The amount of steam used is also checked by consideration of the area of the nozzles in use and the steam supply pressure.

Water pressure gauges and thermometers are provided at various points in the gas stream through the gas treatment plant, and recording pressure gauges are provided for the bottom of the retort, for the gas collecting main, for the sample meter inlet, and for the station meter outlet. In addition, there is a six-point temperature recorder, which has been used for recording the temperature of thermocouples inserted in the gas offtake and at three points at different levels in the centre of the coke cooling chamber.

EXPERIMENTAL WORK CARRIED OUT AT CROYDON TEST PLANT DURING 1936, 1937 AND 1938

Outline of Test Programme

The test programme may be conveniently divided into three parts:

Part 1	.. ..	1936
Part 2	.. ..	1937
Part 3	.. ..	1938

Part 1.—In April, 1936, the static vertical retort plant was put into operation, the gaseous and liquid products of carbonization passing into the Gas Works mains without measurement. This arrangement was made so as to enable the staff to concentrate upon and become familiar with the special operating conditions pertaining to static vertical retorts.

As the design of plant was also under test—which demanded prolonged operation—there was no need to assemble gas making results during the first few months. It was also appreciated that on a new design fundamental modifications might well be necessary and that, until the process had been shown to work successfully, there was no need to build the gas treatment plant. Fortunately, from its start the static vertical retort worked without any trouble and during 1936 carbonized 1,250 tons of coal, of which over 1,000 tons were Durham Run-of-Mine coals.

Part 2.—Early in 1937 the complete gas treatment plant was started up and during the year a large number of tests were carried out in which accurate data were obtained. The programme covered the carbonization of some 850 tons of different well-known Durham Run-of-Mine gas coals at various calorific values. The results of these tests are discussed subsequently in the Paper.

Part 3.—In 1938 the experimental programme was continued by the carbonization of 700 tons mainly of well-known gas coals from Yorkshire, Nottinghamshire, Scotland and Kent at different calorific values. The sole difference between the plant employed in Part 2 and Part 3 was that during the winter of 1937 the coal charging car was modified to demonstrate a principle which it was desired to embody in a commercial design of plant.

Between Part 2 and Part 3 of the programme, the retort was cooled down for inspection and to determine whether any unexpected faults arose in the cooling down or reheating processes. At the conclusion of the whole test run in October, 1938, the retort and cooling chamber were examined and found to be in thoroughly sound condition. By this time the retort had carbonized 2,800 tons of coal and had been under heat for 670 days. From the commencement of operation in April, 1936, to the shutting down of the plant at the conclusion of the test programme in October, 1938, no

alterations or repairs to the static vertical retort were required.

Data Obtained from each Gas Making Test

The data obtained from each gas making test included the following:

(*a*) The total weight of coal used.

(*b*) The average weight of coal for each charge.

(*c*) The proximate analysis of the coal and the crucible swelling number.

(*d*) The volume of H_2S-free gas made from each charge, corrected to 60° F. and 30 in. Hg. sat.

(*e*) The average gross calorific value of H_2S-free gas made from each charge, also corrected to 60° F. and 30 in. Hg. sat.

(*f*) The average volumetric analysis of the H_2S-free gas made.

From the above data were calculated for each test the average coal throughput per 24 hr., the amount of gas made per 24 hr. and its mean calorific value, the volumetric and thermal yields of gas per ton of coal, the yield of each constituent gas per ton of coal, and the hydrocarbon enrichment value (H.E.V.) of the gas made per ton of coal.

The gas yields per ton were calculated both on the basis of the raw coal, as used, and, for comparative purposes, on the basis of "normal" coal, *i.e.*, coal having that moisture and ash content which is typical of the particular type of coal used, based upon the samples tested. This method of comparing results for "normal" coals has in this instance been preferred to the method of comparing results on coals with a standard ash *plus* moisture content of, say, 8 per cent. The latter method, when employed for comparing results on coals from, say, Scotland and Yorkshire, may give results which are commercially misleading.

In addition to the above data, records were kept for each charge of the amount of gas made and its mean recorded calorific value for each hour of working; of the retort heating flue temperatures, which were read every three or four hours (but were not adjusted any more frequently than in normal Gas Works practice); and of the coke cooling chamber steaming conditions.

The dry tar and total liquor yields, with corresponding samples, were obtained over each 10 to 11 day run, this period sometimes embracing gas making tests at more than one calorific value.

During some of the tests, bulk samples of the coke produced were graded by means of 1½ in. and ¾ in. square mesh screens, and samples of the two larger sizes of coke produced—after the largest had been broken down to between 1½ in. and ¾ in.—were submitted to combustibility tests at the Fuel Research Station.

Correction of Gas Yields to Conform with Normal Gas Works Practice

During all tests the gas was metered without removal of H_2S, the net volume produced from each coal charge was corrected to 60° F. and 30 in. Hg. sat., a correctly proportioned sample was collected by means of the sampling meter geared to the main meter, the H_2S content of the sample was determined, and the volume of H_2S-free gas thence calculated. The true mean calorific value of the H_2S-free gas from each charge was determined from the correctly proportioned sample by means of a Boys standard calorimeter, preceded by a small purifier.

The multiple of the above two figures for the corrected volume and gross calorific value of H_2S-free gas gives the true thermal yield of purified gas, but the volume figure is lower and the calorific value figure is higher than would be obtained in normal Gas Works practice, since no air was admitted to the gas for revivification of oxide during purifier working. Oversight of this fact may lead to the claiming of fictitiously good results, particularly in processes in which the final calorific value of the gas is obtained by the internal production of blue water gas.

To allow for the customary 3 per cent. air admission prior to purification, all gas volume and analysis figures tabulated in this Paper contain 2·4 per cent. extra N_2 and 0·2 per cent. extra residual O_2, while the corresponding correction factor of 0·974 has been applied to all calorific values.

Summary of Results Obtained

Table 1 gives some typical results on the static vertical retort test plant.

DISCUSSION OF RESULTS OBTAINED AND COMPARISON WITH KNOWN RESULTS OF OTHER METHODS OF CARBONIZATION

Relationship between Thermal Yield per ton of Coal and Calorific Value of Gas

The "steaming curves" forming Figures 1 and 2 show graphically the relationship between the thermal yield per ton of coal and the calorific value of the gas, from different types of coal and different types of carbonizing plant.

Table 1.—*Typical Results obtained on the Static Vertical Retort Test Plant*

	Durham: Run-of-Mine. Wear Special.	Durham: Run-of-Mine. Average Quality.	S. Yorks.: Washed Doubles.	S. Yorks.: Washed Doubles.	Notts.: Screened.	Notts.: Screened.
1	2	3	4	5	6	7
Gross calorific value of gas, B.Th.U. per cu.ft.	504	505	500	476	474	453
Charging cycle, hr.	9	8¼	8	8	8¼	8¼
Coal throughout, tons per day	5·50	6·22	6·08	5·625	5·887	4·872
Retort Steam, per cent. on coal	20	13	14·5	16	14·5	20
Number of charges forming test	28	28	30	24	27	29
Gas made per day, cu.ft.	102,900	103,400	113,200	118,100	108,200	105,950
" " " " therms	518·5	522	566	562·5	513	480
Yields per Ton of Coal as used:						
Gas yield, cu.ft.	18,710	16,620	18,620	21,000	18,380	21,750
" " therms	94·3	83·9	93·1	100·0	87·1	98·5
Dry coke, cwt.	13·05	13·25	12·45	12·5		11·15
Equivalent 10 oz. liquor, gal.	33·3	29·9	34·9	33·8	30·0	36·0
Dry tar, gal.	12·0	12·1	15·0	15·2	12·5	14·5
CO_2, O_2 and N_2 in gas, per cent.	8·0	7·7	8·35	7·5	8·35	8·0
Hydrocarbon Enrichment Value of gas on coal as used, therms	39·6	35·2	38·8	38·2	33·5	34·8
Proximate Analysis of Coal, per cent.:						
Moisture	2·15	3·12	3·09	2·42	7·20	7·21
Volatile matter	33·07	33·13	35·70	35·57	34·30	34·40
"Fixed carbon"	58·93	55·85	57·53	58·35	52·88	53·60
Ash	5·85	7·90	3·68	3·66	5·62	4·79
	100·00	100·00	100·00	100·00	100·00	100·00
Moisture plus Ash, per cent.	8·00	11·02	6·77	6·08	12·82	12·00
Crucible swelling number	7–7½	6½–8	6½–7½	6½	4	4

Figure 1 shows the steaming curves for continuous vertical retorts, intermittent vertical chambers, and the static vertical retort at Croydon, when working on average Durham Run-of-Mine coals containing 10 per cent. ash plus moisture. The continuous vertical retort curve down to 475 B.Th.U. represents results which have been found obtainable, and the chain dotted portion from 475 to 450 B.Th.U. represents the

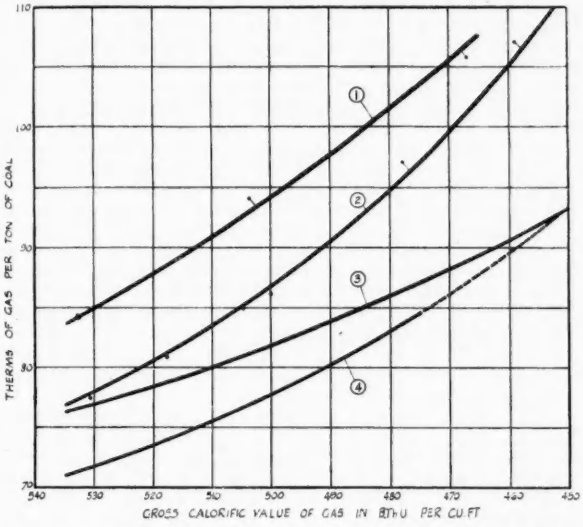


FIGURE 1.—*Steaming Curves for Durham Run-of-Mine Coals when Carbonized in Static Vertical Retorts, Intermittent Vertical Chambers, and Continuous Vertical Retorts.*

Curve 1.—Static Vertical Retort—Durham Run-of-Mine — Wear Special — 8 per cent. (H_2O + Ash)
Curve 2.—Static Vertical Retort—Durham Run-of-Mine — Average Quality —10 per cent. (H_2O + Ash)
Curve 3.—Intermittent Vertical Chambers—Durham Run-of-Mine —Average Quality—10 per cent. (H_2O + Ash)
Curve 4.—Continuous Vertical Retorts—Durham Run-of-Mine — Average Quality—10 per cent. (H_2O + Ash)

theoretical effects of further dilution with 300 B.Th.U. blue water gas. The intermittent vertical chamber curve has been plotted from the results published in the Paper by J. S. Thorman.[8] This figure also shows one steaming curve for a static vertical retort when working on Wear Special coal with 8 per cent. ash plus moisture.

Figure 2 shows the static vertical retort steaming curves for South Yorkshire Washed Gas Doubles, South Yorkshire Screened, Nottinghamshire Screened, and Kent Run-of-Mine coals.

Reading the salient figures from the curves on Figure 1 it is possible to summarize briefly the comparative gas making results of the different types of carbonizing plant when carbonizing average Durham Run-of-Mine coals. These are shown in Table 2.

TABLE 2.—*Therms per Ton from Various Types of Plant at Different Calorific Values of Gas*

Coal : Average Durham Run-of-Mine Coals ; 10 per cent. moisture plus ash

	Therms per Ton.		
Calorific Value of Gas, B.Th.U.	475	500	525
1	2	3	4
Static vertical retorts	97	87	79
Intermittent vertical chambers..	87	82	77·5
Continuous vertical retorts ..	84·5	78	73

From this table certain deductions may be made:

(*a*) The static vertical retort gives an appreciably higher thermal yield than either intermittent vertical chambers or continuous vertical retorts, when carbonizing Durham Run-of-Mine coals.

[8] Thorman, J. S. *Trans. Inst. Gas Eng.*, 1930-31, **80**, 364.

(*b*) As the calorific value falls this advantage of the static vertical retort increases.

This increased thermal yield may be regarded as being due to enrichment of the water gas by gaseous hydrocarbons of high calorific value. In the case of static vertical retorts carbonizing average quality Durham Run-of-Mine coals (Figure 1, Curve 2) the calorific value of the water gas is equivalent to 330 B.Th.U. over the whole range from 530 to 460 B.Th.U. per cu.ft. The mechanism by which this increased yield of gaseous hydrocarbons is obtained is probably due to a combination of the following factors:

(i) The preservation of hydrocarbons which would otherwise be degraded into hydrogen and carbon through contact with the hot surfaces in the retort.

(ii) The interaction of hydrogen and some of the condensable hydrocarbon products of coal distillation, whereby hydrocarbon gases are formed which subsequently remain stable at normal atmospheric temperatures.

It is quite feasible that the above combination of conditions should give rise to an increased thermal yield of gaseous hydrocarbons without any appreciable reduction of volumetric tar yield, since such condensable tar vapours as are converted into permanent gases could simultaneously be replaced by the preservation in condensable form of tar vapours which would otherwise be subjected to complete degradation.

In considering the variation in yield of gas when a given coal is subjected to the process of steaming in continuous vertical retorts, intermittent vertical chambers and static vertical retorts, it is desirable to remember the differing conditions obtaining in these three systems.

In continuous vertical retorts the process of steaming is continuous and is counter-current to the continuous flow of coal down the retort. The quality of the water gas remains constant. The descending cold coal charge, passing into the retort, meets the uprising stream of hot coal gas and water gas, with the result that there is a tendency to produce a

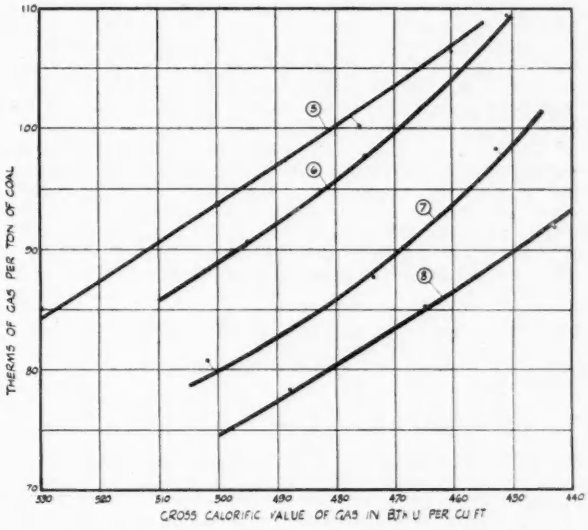


FIGURE 2.—*Steaming Curves for South Yorkshire, Nottinghamshire, and Kent Coals when Carbonized in Static Vertical Retorts.*

Curve 5.—S. Yorks. Washed Gas Doubles—6 per cent. (H_2O + Ash)
Curve 6.—S. Yorks Screened—6·5 per cent. (H_2O + Ash)
Curve 7.—Notts. Screened—12·0 per cent. (H_2O + Ash)
Curve 8.—Kent Run-of-Mine—9·5 per cent. (H_2O + Ash)

certain amount of low-temperature distillation products. This leads to an increased tar yield and a lower yield of coal gas therms.

In intermittent vertical chambers the process of steaming is mainly carried out when carbonization of the stationary charge of coal is complete. To obtain a final calorific value

of gas the same as that from continuous vertical retorts, it is necessary to steam at a higher rate per hour, with consequent adverse effect on the quality of the water gas under prolonged steaming conditions. On the other hand, the stationary charge gives less tendency for production of low-temperature distillation products from the coal. In balance over a wide range of calorific values, intermittent vertical chambers give a higher thermal yield than do continuous vertical retorts.

In static vertical retorts the best features of both these methods are combined. The process of steaming is continuous and good quality water gas is made throughout the cycle by contact between superheated steam coming up from the cooling chamber and red hot coke below the coal charge. In addition, the stationary charge gives less tendency for the production of low-temperature products from the coal. Further, the continuous passage of water gas and uncracked steam around or through the hot stationary coal charge leads to enrichment of the water gas by the mechanism already discussed.

Table 2 shows that, in comparison with a yield of 84·5 therms per ton on continuous vertical retorts, intermittent vertical chambers would make 87 therms per ton, whilst the static vertical retort would make 97 therms per ton—these figures relating to the production of 475 B.Th.U. gas from an average quality Durham Run-of-Mine coal containing 10 per cent. inerts.

The degree of apparent enrichment of the water gas in the static vertical retort process is not the same for all types of coal. As has already been mentioned, this effect with Durham Run-of-Mine coal is equivalent to diluting the coal gas with 330 B.Th.U. water gas throughout the range of calorific values tested. On the other hand, Curves 6 and 7, Figure 2, show that the results with South Yorkshire and Nottinghamshire Screened coals correspond with a diluent gas having a calorific value of 315 B.Th.U. per cu.ft. Curves 5 and 8 for South Yorkshire Nuts and Kent Run-of-Mine coal indicate that, as the volume of water gas was increased, the calorific value of the diluent gas fell off steadily to less than 300 B.Th.U. This suggests that the main influence in causing the apparent enrichment of the water gas in static vertical retort carbonization is the preservation of hydrocarbons which would otherwise be degraded into hydrogen and carbon through contact with the hot surfaces in the retort. Consequently less enrichment by gaseous hydrocarbons can be expected either (*a*) from coal charges which have a high porosity and through which the gaseous products of distillation can travel with comparative ease and thus be subjected to comparatively little overcracking, or (*b*) from coal charges which give rise to small yields of hydrocarbons due to the poor nature of the coal itself.

The thermal yield per ton obtainable from the static vertical retort on the different coals tested, when making 525, 500, and 475 B.Th.U. gas, are given in Table 3. The results

TABLE 3.—*Thermal Yields per Ton Obtainable from the Static Vertical Retort on Different Coals*

Description of Coal.	Normal H_2O + Ash in Coal. Per Cent.	Therms per Ton "Normal" Coal.		
		At 525 B.Th.U.	At 500 B.Th.U.	At 475 B.Th.U.
1	2	3	4	5
Durham, Run-of-Mine, Wear Special	8·0	86	94	104
South Yorkshire, Washed Gas, Doubles	6·0	86	94	102
South Yorkshire, Screened	6·5	81	89	97
Durham, Run-of-Mine, Average Quality	10·0	79	87	97
Scottish Coking, Screened and Nuts	10·5	—	(85)	93
Nottinghamshire, Screened	12·0	—	(80)	88
Kent, Run-of-Mine	9·5	—	(75)	82
Scottish Feebly Coking, Screened	16·5	—	—	81

are derived from the "steaming curves" in Figures 1 and 2 for all except Scottish coals. For the latter, the figures given have been calculated from the actual results on the assumption that the diluent gas would have a calorific value of about 300 B.Th.U. over the small range concerned. Where the calorific value is above the maximum that could be maintained without substantial reduction of daily gas output, the yield has been omitted. Where a slight reduction of daily gas output would be necessary to keep the calorific value up, the yield is given in brackets.

Range of Calorific Values of Gas Obtainable

Table 3 also brings out one of the limitations of carbonization in static vertical retorts, namely, that there is an upper limit in calorific value that can be reached whilst maintaining normal gas output. The reason is not difficult to find. The cooling of the coke by means of steam results in the passage of superheated steam into the carbonizing chamber, with consequent production of water gas and a fall in the calorific value of the gas made. The maximum calorific value that can be obtained in normal operation depends upon the physical nature of the coal, the reactivity of the coke produced from the coal, and the calorific value of the coal gas made during the carbonization of the coal. If the charge of coal be dense, producing a coke of relatively poor reactivity and yielding gas of high calorific value, *e.g.*, Durham coal, a calorific value of about 530 B.Th.U. per cu.ft. can be obtained. If, however, the charge be porous, producing a coke of relatively high reactivity, and yielding a gas with a lower calorific value, *e.g.*, Nottinghamshire coal, a calorific value of about 500 B.Th.U. appears to be approximately the upper commercial limit.

Of course, if the introduction of steam be substantially reduced and the cooling of coke be effected by standing the coke in the cooling chamber for a sufficiently long time to transfer its heat to the surrounding air or by circulating cooling water through a jacket around the cooling chamber, then a gas of higher calorific value can be obtained. In these circumstances, however, there is either a loss of output or a complication in design; further, the advantages as regards therms per ton in comparison with intermittent vertical chambers vanish.

Therefore, unless the static vertical retort can operate at calorific values to permit of internal cooling of the coke by means of steam, other forms of carbonizing plant, such as intermittent vertical chambers with external quenching of the coke, will prove to be a more economical proposition.

Control of Calorific Value of Gas

When carbonizing any given coal, the calorific value of the gas made can be changed over wide limits without altering the carbonizing cycle and without substantially modifying the volumetric gas output per retort per day. This is an advantage which the static vertical retort process has in comparison with the intermittent vertical chamber process, wherein change in calorific value usually involves change in carbonizing cycle.

A change in the calorific value of the gas made in a static vertical retort is effected by modifying the depth of residual hot coke left in the retort. For example, if the static vertical retort is making gas of high calorific value, the carbonized charge is lowered until the top of the pad is about 2 feet above the bottom of the heating flues.

If it is then required to make gas with calorific value 25 B.Th.U. less, the carbonized charge is lowered only until the top of the pad is about 3 feet above the bottom of the heating flues and the rate of steaming is slightly increased. No change is necessary in the time of the carbonizing cycle. In other words, by the adjustment of the ratio of height of uncarbonized coal to the previously carbonized charge within the influence of the heating flues, and by the adjustment of the rate of steaming, it is possible to vary the calorific value of the gas over wide limits.[7]

Rate of Carbonization in Static Vertical Retorts

The carbonizing cycle varied from 8 to 9¼ hr. As already indicated, the change in cycle is not necessitated by any alteration in the calorific value of the gas to be made. It is a function of the type of coal to be carbonized.

The 9-hr. cycle maintained on Durham Run-of-Mine coal is one to two hours faster than can be maintained for intermittent vertical chambers having the same minor axis width at the bottom of the charge and working at the same combustion

[7] British Patent No. 501, 394.

chamber temperatures. This increased speed of carbonization in the static vertical retort is attributed partly to the heat conduction from the hot coke below the coal charge and partly to the heat carried up by the steam and water gas, *i.e.*, it is due to internal heating. In this respect the static vertical retort is more akin to the continuous vertical retort than to the intermittent vertical chamber.

Yorkshire Nuts give a more porous charge than Durham Run-of-Mine coal, and it is found possible to obtain a higher gas output per day from the nut coal at any given calorific value. This is in accordance with experience gained with continuous vertical retorts and supports the view that the rapid rate of carbonization is assisted by internal heating.

Tar: Yields and Characteristics

The yield of tar varied from 12 gal. per ton with Durham Run-of-Mine coals to 15 gal. per ton with Yorkshire Washed Nuts.

A reduction in the calorific value of the gas did not appear to lead to any substantial increase of the tar yield, except when coals of low caking properties are being carbonized. The yield of tar, which is at least as high as the yield obtained from intermittent vertical chambers on the same coal, seems to show that the high thermal yield of gas obtained for the static vertical retort is not produced by gasification of the tar.

Characteristics of Static Vertical Retort Tar

Table 4 summarizes the most important characteristics of four typical static vertical retort tars representing four different types of coal. The table illustrates the range of properties to be found in static vertical retort tars according to the type and grading of coal carbonized.

Table 4.—*Characteristics of Static Vertical Retort Tars*

Properties of the Dry Tars.	Durham: Run-of-Mine.	S. Yorks: Screened.	Notts: Screened.	Scottish: Feebly Coking Doubles.
1	2	3	4	5
Distillation of the Dry Tars, per cent. wt.:				
Oils to 200° C.	4·1	5·8	6·7	5·5
200–230° C.	6·2	6·5	9·1	7·5
230–270° C.	10·0	10·2	11·4	10·6
270–300° C.	4·7	4·5	6·4	7·7
300–350° C.	11·1	11·2	12·9	12·0
Pitch at 350° C.	63·5	61·4	52·4	55·8
Loss	0·4	0·4	1·1	0·9
Specific Gravity at 60° F.:				
Dry tar	1·178	1·148	1·126	1·117
Oils to 200° C.	0·936	0·927	0·927	0·910
200–230° C.	1·014	1·000	0·998	0·981
230–270° C.	1·036	1·029	1·024	1·007
270–300° C.	1·057	1·051	1·047	1·033
300–350° C.	1·094	1·085	1·078	1·068
K. and S. Point of pitches	70° C.	64° C.	64° C.	65° C.
Crude Tar Acids, per cent. by vol.				
In oils 200–270° C.	17·0	26·0	28·0	32·0
Calculated to dry tar	3·2	4·9	6·4	6·4
Naphthalene, per cent. by wt.:				
In oils 200–270° C.	29·0	12·5	5·0	Nil at 60 °F.
Calculated to dry tar	4·7	2·1	1·0	
Free carbon, per cent. by wt.	8·1	7·5	6·5	7·1

Table 5 compares the properties of tar produced from a typical South Yorkshire coal when carbonized in modern coke ovens, continuous vertical retorts, and static vertical retorts.

It will be evident that the properties of static vertical retort tars are intermediate between those of tars produced in coke ovens and in continuous vertical retorts. The tar produced in static vertical retorts is moderately to highly aromatic in nature, depending on the coking quality and the grading of the coal. In the case of Durham coals, the tar resembles fairly closely a coke oven tar. In the case of a feebly coking Scottish coal, the tar, though less aromatic in nature than that from Durham coal, is quite different in character from the tar which would be produced from such a coal in continuous vertical retorts. Cracking conditions in the static vertical retort are not so drastic that the individuality of the coal is obliterated. Thus, other conditions being the same, the tar acid content of the tar increases and the naphthalene content decreases with increase in the oxygen content or decrease in the coking quality of the coal.

Road tars have been prepared from the crude tars by straight distillation in a glass flask. The road tars of 25 sec. viscosity at 30° C. in most cases comply completely with the British Standard Specification for No. 1 road tar. In the case of those tars containing the highest amounts of tar acids, the tar acid concentration of the road tars was slightly higher than is allowed by the Specification, but this feature would be absent in road tars of higher viscosity and could be readily overcome in normal distillation technique, in which road tars are rarely prepared by straight distillation. There is no difficulty in the production of road tars with the specific gravity required by the Specification. Moreover, the free carbon is present in but medium amount, and its content is neither too high nor too low to enable the free carbon clause of the road tar Specifications to be fulfilled.

Table 5.—*Comparative Properties of Tars from Static Vertical Retorts, Coke Ovens, and Continuous Vertical Retorts*

South Yorkshire Coal

	Modern Coke Ovens.	Static Vertical Retorts.	Continuous Vertical Retorts.
1	2	3	4
Specific Gravity at 60° F.:			
Dry tar	1·17	1·148	1·09
Oils to 200° C.	0·950	0·927	0·905
Oils 270–300° C.	1·070	1·051	1·010
Pitch Yield at 350° C., per cent. by wt.	65	61·4	51
Crude Tar Acids, per cent. by vol.:			
In oils, 200–270° C.	14	26·0	35
Calculated to dry tar	3	4·9	10
Naphthalene, per cent. by wt. (at 60° F.):			
In oils, 200–270° C.	35	12·5	Trace
Calculated to dry tar	7	2·1	Trace
Free Carbon, per cent. by wt.	6	7·5	3

Coke: Yields, Grading and Characteristics

The grading of the coke made from different coals is set out in Table 6. This table summarizes the comparative results of coke grading tests carried out under normal condi-

Table 6.—*Grading of Dry Coke as Produced from the Static Vertical Retort*

Description of Coal.	Charging Cycle, Hr.	Calorific Value of Gas, B.Th.U. per Cu.Ft.	Grading of Dry Coke, Per Cent.		
			All on 1½ In. Sq.	1½ In. to ¾ In. Sq.	¾ In. to 0 (Breeze).
1	2	3	4	5	6
Durham (Run-of-Mine)	9	500	61	24	15
South Yorkshire (Screened)	8½	495	51	35	14
Nottinghamshire (Screened)	8½	474	38	35	27
Kent (Run-of-Mine)	9½	488	59	27	14
Scottish (mixture of 3 coking and 2 feebly coking)	8¾	472	47	36	17

Table 7.—*Density of Dry Screened Coke from the Static Vertical Retort*

Description of Coal.	Crucible Swelling No.	Cu.Ft. per Ton of Coke as Made.	Cu.Ft. per Ton of Coke Above 2 In.	Retort Charging Cycle, Hr.
1	2	3	4	5
South Yorkshire (Nuts)	6½	84	96	8
South Yorkshire (Run-of-Mine)	6	80	89	8½
Durham (Run-of-Mine)	8	72	81	9

tions of retort working. All coke sampled was submitted to appreciable breakage by being first run up the inclined drag bar conveyor and then dropped fully 10 ft.

The density of the coke made from different coals is set out in Table 7. In this table density is expressed as the number of cu.ft. occupied by one ton of the coke.

All figures for coke density were determined by means of a cu.yd. box.

From the information available, it appears that:

(*a*) On the basis of the same coal and the same graded size of coke, screened static vertical retort coke is lighter than that produced from intermittent vertical chambers but heavier than that produced from continuous vertical retorts.

(*b*) On the basis of the same coal and the same calorific value for the gas made, the coke produced from the static vertical retort contains more breeze and is of smaller maximum and average size than that produced from intermittent vertical chambers, being more akin in these respects to continuous vertical retort coke.

The above comparisons refer to dry coke.

Characteristics

In order that the assessment of coke quality from the static vertical retort should be impartial, it was arranged that all coke testing should be carried out at the Fuel Research Station. The tests were carried out on the coke in a 16 in. vertical bar grate according to the method whereby a fixed bulk of coke is ignited by the minimum quantity of gas required to enable it to support independent combustion. The rate of radiation from the fire is observed throughout the burning of the coke. The residue left at the end of the test is weighed.

In all, some 18 tests have been carried out, including a number of samples from other systems of carbonization. By permission of the Director of Fuel Research, Table 8 is included, which summarizes these tests.

The figures in columns 2 and 3, for cokes from South Yorkshire Gas Nuts, show that the static vertical retort coke produced on an 8-hr. coking cycle was superior in all respects to horizontal retort coke produced on an 11-hr. coking cycle from coal of this type.

The figures in columns 4, 5 and 6, for cokes from Nottinghamshire Screened coal, show that static vertical retort coke is less easy to ignite than continuous vertical retort coke from the same coal. The longer period of intense fire conditions on the static vertical retort coke was due simply to its greater density.

The figures in columns 7, 8 and 9, for cokes from average quality Durham Run-of-Mine coal show but little difference between static vertical retort and intermittent vertical chamber coke from this coal. As regards heat (but not time) for ignition, the intermittent vertical chamber coke was the better, but the static vertical retort coke gave the hotter fire. It is noticeable that prolonging the charging cycle by ¼ hr. longer than that necessary to complete carbonization (see columns 7 and 8) makes the static vertical retort coke a little more difficult to ignite.

Static vertical retort coke from a Wear Special Durham Run-of-Mine coal (column 10) was in all respects noticeably superior to that from the average quality Durham coal.

The test figures for static vertical retort mixed coke from 5 different Scottish coals (column 11) show results between those for the two qualities of Durham coals, except that the duration of intense fire conditions from the Scottish coke was comparatively short, mainly on account of this coke being of low density.

Consideration of the figures shows that the type and grading of the coal carbonized have a great influence on the characteristics of the coke. In fact, it appears that the influence of the type of coal is greater than the influence of the type of retort.

TABLE 8.—*Combustibility Tests*

Results of Tests carried out at the Fuel Research Station in an open Vertical Bar Grate on Cokes from the Static Vertical Test Retort, with comparative results for other types of carbonizing plant

Description of Coal	South Yorkshire Gas Nuts		Nottinghamshire Screened			Average Quality Durham Run-of-Mine			Wear Special Quality Durham Run of-Mine	Scottish Screened (Mixture)
1	2	3	4	5	6	7	8	9	10	11
Type of carbonizing retort or chamber	Static Vertical	Horizontal	Static Vertical	Continuous Vertical		Static Vertical		Intermittent Vertical	Static Vertical	Static Vertical
Charging cycle, hr.	8	11–11¼	8¼	—	—	8¾	9	12	9	8¾
Particulars of Coke as Charged to Fire:										
Graded size, in.	Uncut ¾–1½	— 1–1½	Uncut ¾–1½	Uncut 1–1½	Uncut 1½–2	Cut and Uncut ¾–1½	Cut and Uncut ¾–1½	Cut and Uncut ¾–1½	Uncut 1–1½	Uncut ¾–1½
Charge weight, lb.	10	10	9⅜	7⅞	7½	11⅛	11	11¼	11	10
Moisture, per cent.	0·7	0·5	1·8	1·85	2·0	0·35	0·5	1·35	0·0	0·8
Volatile matter, per cent.	0·6	0·5	1·3	0·75	1·0	1·25	0·6	1·1	1·6	0·8
Ash, per cent.	5·1	7·0	5·45	4·45	4·6	10·65	7·8	10·75	7·2	6·2
Number of tests	1	1	2	2	2	2	4	2	1	1
Average Results:										
B.Th.U. for ignition	4,500	5,600	3,360	2,655	2,635	5,000	5,200	4,450	3,080	4,500
Time to reach intense fire conditions, min.	122	128	79	58	45⅛	132	147	134	88	110
Maximum heat units radiated per min.	1·84	1·34	1·90	1·77	2·16	1·49	1·49	1·39	1·81	1·57
Duration of intense fire conditions, min.	114	68	116	92	90½	101	90½	97	108	85
Percentage weight of coke charge consumed	71	61	77	79	80	61	63	62½	71	64

In conclusion, the Authors wish to express their thanks to the Chairman and Directors of the Croydon Gas Company for the facilities made available at the Waddon Works for the erection and operation of the Test Plant; to the Chairman and Directors of the Woodall-Duckham Companies for their permission to publish the results of the investigation; and to the team of engineers, operators and chemists who carried out the detail work upon which this Paper is based. They wish in particular to thank Mr. H. H. Carey, who was throughout in charge of the operation of the Test Plant, for his valuable help in the preparation of the Paper.

Distribution and Sales Organization

by

NOEL S. SMITH, Assoc.M.Inst.Gas E.

(Distribution Engineer and Sales Manager, Bristol Gas Company).

Communication No. 209

[Abstract]

ORGANIZATION

Functions

Since 1932, distribution, which includes the sale of appliances, has functioned as a separate department controlled by the Distribution Engineer and Sales Manager, under the guidance of the Secretary and Commercial Manager and the Engineer and Works Manager. Questions affecting financial and public policy are submitted to the Secretary and engineering and technical matters to the Engineer.

Concentration of control of all sections dealing with distribution and sales was recommended by these officials as a means of strengthening the Company's efforts to meet intensified competition. They drew up, in detail, a clearly defined distribution policy and indicated how the existing organization could be co-ordinated and extended to the best advantage. The scheme was adopted and the organization of distribution and sales today operates as originally constituted on co-ordinated lines. Linking the various sections necessitated a certain amount of reorganization, but every assistance was afforded by both senior and junior officials and no major difficulties were encountered. Since the duties of distribution management differ according to varying policies, the functions of the Bristol organization are here recorded.

Supply

To deal with all enquiries and applications for new mains, services and appliances, and correspondence in connexion therewith so far as the technical and practical sides of these transactions are concerned.

Responsibility for laying new mains and services, the installation of meters and appliances and the requisitioning of materials required in connexion therewith.

Public lighting.

Co-operation with builders, architects and estate agents regarding the adoption of gas in new property.

Co-operation with other public services and Local Authorities on matters of common interest.

Survey of district pressures and co-operation with the Works to maintain suitable district standards.

Investigation and remedying of complaints of all kinds, and dealing with all correspondence connected therewith.

Inspection and maintenance of all consumers' appliances, industrial and domestic.

Compilation of data regarding the distribution system.

Education and training of staff and workmen.

Investigation of all problems relating to the supply and use of gas.

Sales

Responsibility for staffing and sales, all records of business done and regular comparative data for noting progress.

To report on all new developments in domestic and industrial appliances and sales policy. To popularize the use of all new approved appliances, as introduced, with the classes of consumers interested.

Co-operation with all local factors and traders in the sale of appliances, with a view to ensuring the adoption of approved apparatus.

Co-operation with appliance manufacturers in order to secure efficiency in all apparatus to meet the local conditions of supply.

Extension of Domestic Business.—Taking census of consumers; inventory of appliances; systematic canvassing.

Extension of Industrial Business.—Taking census of trades and appliances and reviewing possibilities; visiting manufacturers to secure consideration of appliances suitable for their processes; assisting other Undertakings with information and advice.

Publicity and Propaganda.—Organization of district exhibitions, domestic and industrial demonstrations, cookery lectures, etc.; preparation of press articles and general advertising; systematic distribution of literature to special consumers; arranging visits of parties from local organizations and schools to the Company's Works, depots and showrooms for propaganda purposes; lectures to local organizations.

Sections

The area supplied is approximately 30 sq. miles and is fairly compact, despite the fact that the distance between the extreme limits is 13 miles. The Head Office, Radiant House, from which distribution and sales are administered, is in the centre of the city and the Mains and Fittings Sections are in close proximity.

The disposition of the sections of the department is as follows:

Application Section.—At Head Office and also directly responsible to the Secretary. It deals with all applications for supply of gas, changes of tenancy, general enquiries, and issues instructions to the Mains Section for services and to the Fittings Section for internal work.

Mains Section.—Controlled by Mains Superintendent. This is also responsible for public and railway lighting, general and drawing office at Head Office, and workshops and stores at Mains Depot, Maudlin Street.

Fittings Section.—Controlled by Fittings Superintendent and located at Barton Street. It is responsible for all internal fittings, meters, workshops and stores connected therewith, and outdoor salesmen other than canvassers. The Industrial Section is centred here and is responsible, through the Fittings Superintendent, directly to the Distribution Engineer.

Meters (Reading and Prepayment Collection) Department.—Located at Head Office (also directly responsible to the Secretary), and controlled by the Rental Superintendent. It deals with ordinary meter reading, prepayment collection and "coin fixed" complaints.

Showrooms.—These are controlled by the Showroom Manager, who is responsible for the sale of appliances, co-operation with plumbers and ironmongers, cookery demonstrations, and lectures and activities of the Home Service Section.

Canvassers work from Head Office and co-operate with both the showrooms and the Fittings Section. Officials responsible for dealing with architects and builders, and advertising, are located at Head Office.

A diagram of the complete organization will be found in Figure 4.

DISTRIBUTION

Three manufacturing stations supply either direct or by means of holder stations the gas which is carried through a system of interlinked low-pressure mains. These mains are reinforced at various points, chiefly extremities, through governor connexions from high-pressure mains. The manufacturing stations and holder stations are interconnected with a system of "medium" pressure mains; pressures range from "low" to approximately 60 in. w.g.

Policy Relating to the Laying of Mains

Before an application for a supply of gas involving an extension of a main is considered, a block plan of the site must be submitted. An estimate is then prepared, together with a plan showing the mains it is proposed to lay, for approval of the Board of the Company. Should it be considered expedient to lay larger mains than the supply in question necessitates, thereby making it uneconomical, then the application is only debited with the cost of a main sufficient

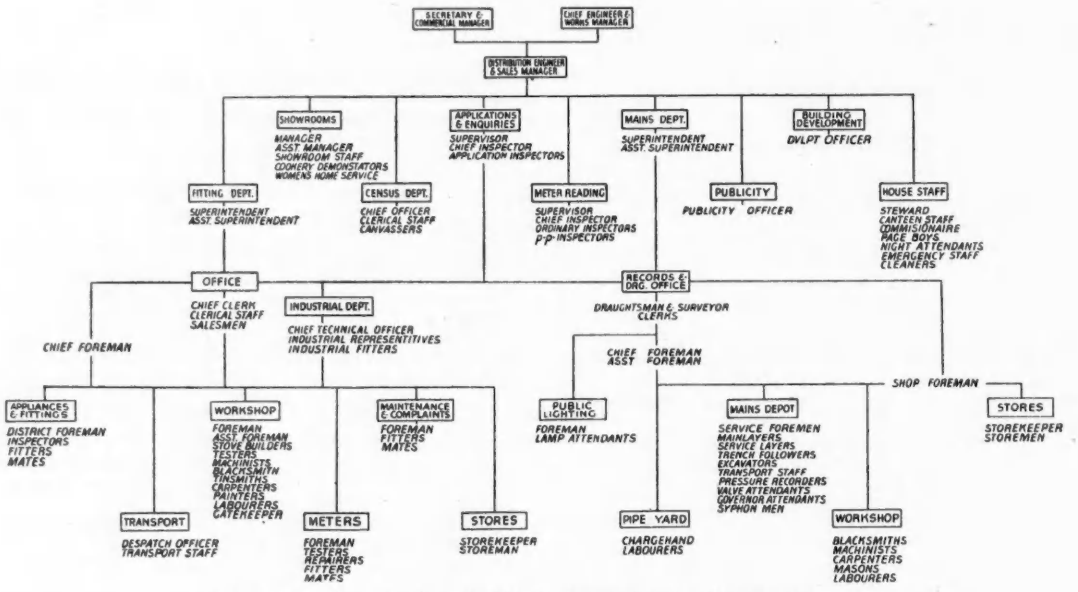


FIGURE 4.—*Organization of Distribution and Sales Department.*

for its requirements. In cases where the cost of laying a main solely to meet the needs of a specific application is beyond the economic limit, the applicant is expected to contribute the difference. The capital expenditure on mains extensions during the past five years averaged £6 2s. 3d. per house erected, whilst over the same period the amount charged to capital for services averaged £1 17s. 7d.

By an agreement between the Bristol Gas Company, the Water Company, the General Post Office, the Corporation Electricity and Highways Departments, and other Local Authorities, each notifies the others of any work to be undertaken in the public highways and affords facilities for inspection during the carrying out of the work. This co-operation has resulted in most amicable working relations between all parties. The Bristol Gas Company's trench followers inspect all openings by these Authorities, examine any exposed property, arrange for repairs, if necessary, and generally safeguard the Company's interest. In all roads which are 50 ft. or more in width, two mains are laid, one in each footway. In roads less than 50 ft. in width (other than concrete) a single main is laid—in the footway where possible. In all concrete roads two mains are laid, but where the width is less than 50 ft. the developer of the estate must excavate and reinstate the trenches in both footways.

During recent years, in the case of concrete roads on housing sites, arrangements have occasionally been made with the Water Company to use one trench in either footway for both gas and water mains, a distance of 1 ft. being kept between the respective supplies. The figures given in Table 1 for excavations in builders' roads (slightly stony ground), including temporary reinstatement, show that a substantial saving is effected by this co-operation.

TABLE 1.—*Cost of Excavations in Builders' Roads*

Size, In.	Cost per Yd. of Excavation and Reinstatement.	
	Jointly.	Independently.
	s. d.	s. d.
4	2 2	4 3
10	4 0	9 9
12	4 5	11 0

The saving in capital expenditure is not the only advantage, for the width of footways planned by many developers of housing sites (often between 5 ft. and 10 ft.) is inadequate to accommodate conveniently gas, water, cables, and, in some cases, sewers.

In recent years there have been a number of cases in the Bristol area of street widening and arterial road development, the road surfaces being of concrete. In cases where the alteration would leave the gas main below the concrete carriage way, the Company prefers that the main should be moved to the footway, and, where necessary, a second main provided in the opposite footway. As it is a matter of mutual interest to free the carriage way from public service supplies, the Highway Authority concerned is asked to contribute towards the cost of the alterations. Each case has been dealt with individually and the Bristol Gas Company has always been relieved of all excavation and reinstatement costs. Where road widening has left the gas main in private property, the whole of the cost of removal and relaying has been borne by the Highway Authority concerned. Where alterations in road levels, except within the old city boundary, as defined in 1853, leave the gas main with inadequate cover, the Local Authority bears the full cost of rendering the main safe.

THIRD PARTY INSURANCE COVERING OPENING AND REINSTATEMENT OF TRENCHES

The Company is covered by insurance for third party risk for work in connexion with mainlaying, from the time the work commences until twelve months after the Local Authority has carried out the permanent reinstatement of the trenches. The policy covers liability for work done by the workmen employed by the Local Authority as well as the Company's own employees. It is based on an agreement between the Company and the Local Authority, whereby the latter takes over the trench for reinstatement 36 hr. after receiving notice from the Company. The annual premium is at the rate of ¼ per cent. (5s. per £100) on the annual wages paid by the Mains Section, plus ¼ per cent. of the labour charges on reinstatements carried out by the Local Authority for the Company, the whole of this premium being paid by the Company.

The total liability of the policy is up to £5,000 in any one year, but not more than £1,000 for any single claim.

Method of Recording Mains, Services, etc.

As long ago as 1850, before the advent of Ordnance Survey maps, the Company made use of a system of maps to a scale of 1/600 (50 ft. to 1 in.), prepared by the then Municipal Engineer. These maps have been continued to the present day and record, in addition to mains, valves, and siphons, the important services. There are in all approximately 1,000 maps, and reference is made by means of a key map of the whole area (scale 6 in. to 1 mile) which is divided and numbered to correspond with the sectional maps.

A set of Ordnance Survey maps (scale 1/2,500) is also used for recording trunk and inter-station mains, and all sizes down to 6 in. A further blank set is used for street refer-

ence. Sketches of mains extensions are kept in loose leaf books, and from these the maps are brought up to date. A card index, filed under street names, records the sketches, details the number of houses supplied off the main and the page of entry in the mains costing book.

Main and Service Pipes

Spun iron pipes are used for sizes 4, 5 and 6 in. and ordinary cast iron for larger sizes for both low-pressure and inter-station mains. All joints on cast iron mains are made with run lead. Long-sleeve steel mains (welded joints) with a double wrapping of medium hessian coated with bitumastic solution and oiled or painted internally are used exclusively for high-pressure distribution. Since 1922, wrought iron or mild steel tubes wrapped and oiled in a similar manner have been used for services. Prior to this date it was the practice to use lead pipes in troughs. Many of these services have since been replaced and today only 50 per cent. of the total are lead. The length of mains and services is as follows:

	Miles
Low-pressure mains	622
Inter-station "medium" pressure mains	21
High-pressure mains	16
Total length of mains	659
Total length of services	434

On arrival all cast iron pipes are tested hydraulically, up to 80 lb. per sq.in. In addition, 5 per cent. of the spun pipes are weighed. Pipes cut for short lengths during mainlaying are measured for thickness and in every case where pipes are drilled, both old and new, the piece taken out is subject to similar treatment. The wrapping, coating, and oiling or painting of each steel pipe are thoroughly examined, both on arrival and again when laying. Air pressure at 100 lb. per sq.in. is applied when testing *in situ*. 1 per cent. of every consignment of service pipes is tested for soundness and the wrapping removed to examine the state of impregnation of the bitumastic solution and external condition of the pipe. The interior is inspected by taking short cuttings from a few lengths and halving them longitudinally.

Effects of Gas Drying

Prior to September, 1935, only one of the manufacturing stations had a dehydrating plant. The effect of subsequent installations at the other two stations is reflected in the figures in Table 2.

TABLE 2.—*Effects of Installation of Dehydrating Plant*

Defects.	1934.	1935.	1936.	1937.	1933.
1	2	3	4	5	6
Stoppages	1,416	1,806	2,657	1,408	1,148
Water in Services	2,008	571	399	84	62
Water in Meters	336	143	194	28	12
Water in Fittings	1,001	349	372	69	10

Coincident with the installation of gas drying plant in 1935 was the replacement of nine men with hand trucks by one man with motor van for siphon pumping.

TABLE 3.—*Average Costs for Mainlaying (including Reinstatement)* 1934 to 1938 inclusive.

Size, In.	Length, Yd.	Average Cost Per Yd.
1	2	3
		£ s. d.
4	58,658	10 10
4*	36,773	5 4
5	24,412	12 3
5*	3,816	6 9
6	39,878	15 1
6*	8,442	8 4
8	16,111	1 1 10
8*	1,520	12 2
10	6,715	1 5 9
10*	263	19 9
12	7,162	1 10 8
12*	399	19 11
14	7,855	1 16 11
18	1,152	2 9 4
18*	427	1 15 6
20	713	2 16 4
20*	296	2 11 8

* Excavation and reinstatement by developer of estate.

BUILDING DEVELOPMENT

During the past ten years approximately 4,000 houses have been erected each year in the Bristol Gas Company's area of supply, the majority by private enterprise. There are ten building zones, and for a number of years the Company has had an official engaged solely in dealing with architects and builders. The Company is a member of the Federation of Building Trades Employers, and the Building Development Officer is the Company's representative. All architects and the principal builders are supplied with ring binders containing a complete selection of literature regarding the Company's apparatus, together with details of policy relating to supply of gas, etc. Similar information is available in the libraries of the Bristol School of Architecture and the Merchant Venturers' Technical College. The development officer watches that such information is kept up to date.

TABLE 4.—*Reinstatement Costs*

Type of Surface.		Highway Authority (Cost per Sq.Yd.). City.	First County Council.	Second County Council.	Urban District Council.
1		2	3	4	5
		£ s. d.	s. d.	£ s. d.	s. d.
Pennant paving	Relay	4 5	3 6		3 7
	New	18 6	9 11		15 2
Cement slab paving	Relay	4 0	3 2		3 7
	New	13 4	10 0		10 11
Cement paving (*in situ*)	All New	11 0	6 2		9 0
Tar paving		5 3	4 6	2 6	4 4
Cement concrete		6 7	5 0		5 5
Cement concrete	Reinforced	17 6			
Pitching	Relay	5 10	4 9		4 10
Pitching, including concrete	Relay	12 6			
Wood paving, including concrete	Relay	1 3 1			18 11
Wood paving and reinforced concrete	Relay	1 7 5			
Edging (Pennant)	Relay	2 9*	2 0*		4 11*
	New	8 7*	4 0*		7 1*
Tarred macadam		6 3	5 2	5 6	5 1
Asphalt on hard core		1 0 10		1 0 1	

* Linear yard.

The average house up to £600 in value is equipped with gas cooker, geyser and wash boiler. The builder provides and fits the two latter appliances and runs the supply for the cooker. In houses of over £600 the geyser is giving place to the multi-point heater. Gas fires in bedrooms are not looked upon with much favour in the smaller type of house, owing to the necessity of constructing a flue. In the higher priced house coal grates still appear as standard equipment, leaving the occupier the choice of a gas fire or electric radiator. The Company allows the builder 10s. for approved fire points run to coal grates (the number being determined by the size of the house) and provides one gas poker free. As explained elsewhere, a charge is made for all service pipes beyond the public highway, but an introductory commission is given to the builder on apparatus purchased by the occupiers. To obtain this the builder must make a formal introduction by handing to the prospective customer one of the Company's introduction cards. The discount allowed on the sale of a cooker more than meets the charge for the service. The electricity undertaking charges for its service, but makes concessions according to the number of points installed, which in most cases result in a free service.

TABLE 5.—*Summary of Applications Made for Supply of Gas*
New Installations only.

Purpose for which Gas is Required.	1935.		1936.		1937.		1938.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
1	2	3	4	5	6	7	8	9
Lighting	358	8·7	106	2·4	173	3·4	113	1·9
Cooking	3,580	87·4	3,744	86·1	4,338	85·7	5,090	87·1
Heating	259	6·3	217	5·0	329	6·5	438	7·5
Water heating	3,493	85·3	3,999	92·0	4,393	86·8	5,324	91·1
Boiling rings	26	0·6	54	1·2	97	1·9	90	1·5
Industrial	8	0·2	17	0·4	36	0·7	16	0·3
Total consumers	4,095	—	4,346	—	5,062	—	5,847	—

The Bristol Gas Company makes a point of offering to

loan appliances to builders for dressing show houses, a practice which is much appreciated.

Architects present a rather different problem from builders, since they dislike constant canvassing but generally are pleased to be kept up to date with literature. Their interest in the smaller type of house is limited to supplying the builder with a plan for a few guineas. When an architect is definitely assigned for the erection of a building, the Company's policy is to make an appointment and endeavour to include as much gas equipment as possible in the specification. This is one of the important parts of the development officer's duties.

The purposes for which gas is required by new consumers are recorded at the time of application and the summary in Table 5 covers the past four years. It will be noted that the demand for gas lighting in new property has almost entirely ceased. Included in the water heating figures are a number of wash boilers fitted in small houses for the additional purpose of supplying hot water for the bath. These appliances do not exceed 5 per cent. of the total, the remainder being mainly geysers. Geysers are installed by builders primarily on account of the hardness of the local water; incidentally, they have created a field for sink heaters.

Hard water has proved a mixed blessing. The adverse side includes inflated maintenance costs for storage and certain types of instantaneous heaters.

The number of services plugged off due to houses being demolished under slum clearance schemes were, however, as follows:

1934	327
1935	365
1936	364
1937	393
1938	873

Public and Railway Lighting

Gas is supplied to four Local Authorities for public lighting, namely, the Corporation of Bristol, two Urban District Councils, and one Rural District Council. The Company has no voice in the lighting of the city area beyond supplying gas. The lamps are the property of the Corporation and are lighted, extinguished and maintained by its own employees. At the present time there are approximately 14,500 lamps in the city, of which 5,200 are gas lamps, mainly square lanterns with two No. 1 mantles. For a number of years the Corporation has been carrying out a policy of replacing gas by electricity. According to a defined programme, the whole of the streets will be electrically lit within the next few years. The Bristol Gas Company has made repeated offers to demonstrate at its own expense the effects of modern gas lighting. The only modern gas lighting within the city area is in the Great Western Railway Company's private road leading to the main station. This road was relit by the Bristol Gas Company two years ago with sixteen 15-light No. 2 Rochester lamps. The illumination conforms to Class C Installation (B.S.S. No. 307—1931) and is the best lit road in the city, but this has made no impression on the Corporation.

In the urban and rural areas there are 1,200 gas lamps. Here the lighting standard is much higher than the gas lighting in the city. The lamps are usually purchased through the Company, which generally advises the respective Councils on public lighting. Maintenance is carried out, if desired, but in all cases the Company supervises the lamps after installation.

The Company maintains all gas lights on the properties of the Great Western Railway Company and the London Midland and Scottish Railway Company; in all there are more than 4,400 nozzles. Several new lighting installations have within recent years been carried out for these Companies.

The Mains Superintendent's staff for dealing with public and railway lighting consists of a lighting foreman (a practical fitter) and eight maintenance men. The men are selected from the younger fitting shop labourers and taken on probation. Their wages are £3 1s. 5d. per week, and their hours are from 8 a.m. to 1 p.m., Monday to Friday, 8 a.m. to 12 noon on Saturday, and two hours each evening, inspecting lamps during lighting hours.

A card index is kept of all lamps maintained by the Company and the costs analysed. The total gas consumption for public and railway lighting for 1938 was 120,600,000 cu.ft.

Fittings Section

The personnel consists of the Fittings Superintendent, an assistant, a general foreman, 4 district foremen (supervising fitting work), 1 maintenance and complaints foreman, 1 shop foreman, 1 meter foreman, 4 district inspectors, outdoor salesmen, the necessary clerical staff, fitters, fitters' mates and labourers—about 500 employees in all. The Industrial and Commercial Section functions as a separate unit attached to the Fittings Section.

Boys commence at the age of 14 and qualify as fitters on reaching the age of 21.

The number of boys now in training is sufficient to meet the demand for fitters without engaging outside assistance.

Fitters are graded according to ability and the grades are revised annually. Plumbing work is not peculiar to any grade, although men showing an aptitude for any special class of work are given such work as far as possible. Men engaged on maintenance work are fully trained gas fitters capable of dealing with all types of apparatus. The cleaning and renovation of cookers and heating appliances is carried out by labourers, 21 being the minimum age for those employed on this work. Testing, drilling, and other machine work is done by "handy men", who are paid a higher rate. The renovation of water heating appliances is carried out by specialized fitters and tinsmiths. The latter also carry out all sheet metal work, including the manufacture of flue fittings.

Foremen and inspectors are provided with complete uniforms, and fitters with uniform hats. All tools are supplied by the Company.

The average cost of fitting appliances is shown in Table 6.

Table 6.—*Appliance Fitting Costs (Average)*

—	1934.	1935.	1936.	1937.	1938.
1	2	3	4	5	6
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Cookers	7 7	7 1	6 9	7 0	7 1
Fires	16 7	15 9	15 5	16 10	17 1
Portable heaters		19 5	18 9	1 1 11	1 1 11
Coke grates		17 0	15 1	17 0	1 0 11
Radiators	1 1 3	1 4 8	16 2	19 3	1 5 6
Wash boilers and washing machines	1 1 2	16 8	13 5	12 11	12 4
Sink heaters	1 17 6	1 12 9	1 12 4	1 11 10	1 15 6
Refrigerators			15 5	15 2	15 0
Geysers				3 18 6	4 0 0

Meters for repair are sent to the respective manufacturers, only minor prepayment adjustments and painting being effected by the Company. During the past five years 6,969 meters have been exchanged for the reasons set out in Table 7.

All meters on return from the district—for whatever cause—and a percentage of each consignment from the makers, are tested for registration, external soundness and passing unregistered gas. In this same quinquennial period, 74,854 meters were tested, of which 68·6 per cent. were correct, 16·1 per cent. fast, 13·1 per cent. slow, and 2·2 per cent. would not pass gas.

The following percentages give an analysis of all escapes, except on mains, reported during the past three years:

Services	2·3
Main taps	8·9
Meters and connexions	14·0
House and cooker pipes	22·8
Appliances other than cookers	27·8
Cooker taps and connexions	17·3
No escape found	6·9

New types of appliances undergo tests to determine combustion standard, thermal efficiency, accessibility for maintenance, general reliability, and fixing details.

Table 7.—*Meters Exchanged During Period from 1934 to 1939*

Reason for Exchange.	Average for 4 Years Prior to 1938.	Percentage of Total Meters on the District.	Number in 1938.	Percentage of Total Meters on the District.
1	2	3	4	5
Escapes at index	608		522	
Escapes at case	119		129	
Not passing gas	102		70	
Not registering	9		9	
Oscillating	111		109	
Noisy	320		233	
Broken index glass	56		48	
Rusty case	84		28	
Dirty index	43		13	
	1,452	1·18	1,161	0·87

Industrial and Commercial Section

In 1931 a number of large industrial consumers began to show reductions in their consumptions. Investigations revealed that there was a marked tendency to displace gas by oil, where possible. The Company had no Industrial Section and consequently little contact with the consumer, who naturally did not consult the Company with regard to his industrial heating problems. Primarily to arrest this decline in consumption, an Industrial and Commercial Section was brought into being.*

At the commencement three trained representatives were appointed. By way of introduction, letters with prepaid postcards were sent to the various firms, offering to send a representative to make a survey of apparatus, give a report, and carry out adjustments free of charge. The offer met with a ready response, and a business friendship was formed to which can be credited much of the increased consumption. The section has built up a census with a record card for each consumer, giving details of all gas, oil, electric and solid fuel apparatus. These cards also show hourly gas rates, sizes of services and meters, records of visits, and annual gas consumptions. Every quarter the section is provided with a list of the principal variations in consumptions for investigation and report to Head Office. Consumers are supplied with technical periodicals and other publications of interest to their particular trade. A well-equipped physical and chemical laboratory is at the disposal of the Section for the testing of apparatus and the investigation of combustion problems.

Today the personnel numbers six fully qualified representatives, two furnace erectors, two assistants, and two maintenance fitters.

There is no need to stress the value of constant contact with the consumer, attractive tariffs, and a live periodic maintenance service. Industrial appliances are often subject to rough usage, with consequent reduced efficiencies and increased fuel costs. A maintenance service which does not safeguard the consumer from rising consumption for no just cause is incomplete and unlikely to retain business. During 1938, 6,127 visits were made, 694 adjustments and tests carried out, 154 specifications prepared, and 252 orders obtained, to the value of £11,000.

The industrial and commercial load is classified into 24 groups, and the following table shows the percentage of consumption in each. Consumptions below 200,000 cu.ft. per annum are not included. During the past five years the industrial and commercial consumption has increased by 50·3 per cent.

Table 8.—*Industrial and Commercial Consumption During the Year 1938*
18·2 per cent. of Total Sale.

Classification.	Percentage of Industrial and Commercial Consumption.
Engineers	27·9
Hotels and restaurants	14·2
Schools and hostels	11·6
Railways	6·0
Fish fryers	5·5
Printers and stationery manufacturers	5·1
Central heating	4·8
Vitreous enamellers	3·6
Miscellaneous space heating	2·9
Bakers and biscuit manufacturers	2·9
Chocolate and sweet manufacturers	2·8
Tobacco manufacturers	1·9
Cabinet makers and wood workers	1·5
Laundries and cleaners	1·5
Stove enamellers	1·3
Paint, varnish and brush manufacturers	1·3
Boot and leather manufacturers	1·1
Metal melters	1·0
Clothing manufacturers	0·8
Brewers	0·8
Brake lining manufacturers	0·7
Corn merchants	0·3
Manufacturing chemists	0·3
Crematorium	0·2

Although only recently constituted as an Industrial Centre, Bristol has functioned as an informal Centre since the inception of the scheme. The membership consists of 13 subscribing members controlling 41 Undertakings, with a total sale of 8,500 mill. cu.ft. per annum.

* Oil is still a formidable competitor in large installations, particularly for central heating, metal melting and bread baking, whilst electricity, having almost entirely displaced the gas engine, is making a strong bid for a further share of the industrial load.

Sales

The hiring of cookers in Bristol commenced half a century ago. Six years later, in 1892, nearly 2,200 had been installed. This progress was too slow for some of the appliance manufacturers, who set up agencies among local ironmongers and other traders and commenced direct sales to the public. Canvassers were employed, and one firm actually operated a hire purchase system. A local barber displayed a cooker in his saloon and made use of his son to follow furniture removal vans, evidently believing that a change of address was a suitable occasion for the installation of a cooker.

Of late years, like most Undertakings, the Company has experienced an abnormal demand from existing consumers for new gas apparatus. The greater part of this business has been the exchanging of black cookers on hire for enamelled cookers on sale or hire purchase, coupled with an increase in the demand for water heaters and wash boilers. Gas fire sales have been disappointing, the local fire season being a very short one, normally extending from the end of September to the beginning of December. Cold weather during the early months of the year does not appreciably assist the sale of these appliances. In annual reports mention has been made of the effect of the mild weather of recent years on the sale of gas, and in this connexion it is interesting to note that during a normal winter's day for every one degree change in temperature the Bristol Gas Company's output is affected by approximately 100,000 cu.ft.

Of other factors which affect the sale of gas, not the least important in many towns is competition. It has already been indicated that the Company's new consumers adopt electricity for lighting. The inventory of apparatus on two districts (see Tables 11A and 11B), which is indicative of conditions in general, discloses that much of the lighting in existing premises has been lost. There is little hope of reclaiming this and, from experience, little possibility of preventing its loss. The figures reveal, too, how other business is being attacked. The resistance to this competition is evidenced in the sale of apparatus. It is well to remember that in future the domestic business will be shared, and the lion's share will go to the most enterprising competitor.

Lest these remarks appear pessimistic, it may be added that the percentage of lost business reclaimed by the Bristol Gas Company—apart from lighting—has shown a definite increase during the past twelve months.

Showrooms

Five years ago the showroom was literally a display room at the Head Office. Today, if a consumer were asked the whereabouts of the Head Office he would probably reply "at the showroom in the centre of the city".

As collectors are not employed, the showroom naturally derives benefit from the fact that consumers must pass through it when calling to pay accounts. During the first fortnight after the quarterly accounts have been rendered it is not unusual for 1,800 people to enter the showroom in a day. Flexibility was aimed at in the design of the display settings. A number of fixed fire surrounds can be entirely encased by wooden screens designed and painted to harmonize with the surrounding walls. The finished effect is a plain offset wall against which cookers or other appliances can be displayed. Variety is given to fixed water heating displays, which are arranged in groups. Multi-point heaters discharge into a stainless metal trough, large storage heaters into a sink, small storage heaters and single-point instantaneous heaters into individual wash-hand basins, whilst geysers are fixed over baths.

The personnel consists of a showroom manager, assistant manager, and 15 salesmen. The salesmen commence as juniors between the ages of 16 and 17, and come direct from secondary schools. The juniors attend technical classes on three evenings per week.

The Company really has no district showrooms. Nevertheless, facilities are not lacking for the display of appliances throughout the whole area of supply. Co-operation with ironmongers and plumbers has been developed to an unusual extent. Five years ago their services were enlisted in the sales organization, and as a commencement an introductory discount was offered for business obtained as a result of recommendations. The discount varies from 7½ to 15 per cent., according to the class of business, and is paid

on hire purchase and sales orders maturing as a result of introduction. No difficulty was experienced in persuading a selected number to display apparatus in their showrooms and windows. The more enterprising asked to be supplied with agreement forms in order to clinch the business on their own premises.

Today the Company has the active co-operation of 70 members in its area. In 47 premises there are window displays provided by the Company, and in only two instances (where the Company has the sole use of the window) is payment made for this privilege. The total amount of business credited to traders, including builders, during the last five years was £95,340.

In addition to traders' displays, there are in the outer areas two district offices with display rooms (without window space), primarily for the payment of accounts. Although only open two days per week, they achieve their main object, and the profit from the sale of apparatus covers the expenses. Four years ago the Company, anticipating the future expansion of the Fittings Section, acquired two double-fronted shops adjoining; the windows of these premises are being utilized for display purposes, pending the necessity for extensions.

Canvassing

Canvassing was adopted by the Company in October, 1933, and was an immediate success. House-to-house calls are made, but each consumer to be visited is notified by letter several days prior to the call. The letter assures the consumer of the Company's desire to maintain a satisfactory service and requests that any cause for dissatisfaction be intimated to the inspector. It will be noted that the canvasser is referred to as an inspector. The men employed in canvassing are all qualified gas fitters from the Company's own staff, with technical training. The Company originally commenced with four men and fitters were invited to make application for the positions, which resulted in a fair number of replies, but the "possibles" did not exceed the demand. The original four, however, all proved successful and two of them have since been promoted to other jobs. Further calls have since been made upon the Fittings Section, but unfortunately not with the same success, several men having to be returned after trial because of their inability to get business. Today there are eight canvassers and it is considered that the source of supply has been drained for some time to come. The average fitter does not make a good canvasser, but the fitter who does possess a flair for getting business proves eminently suitable for the job. The selected men undergo a short instruction course before going out on the district and they are provided with uniform hats and carry pliers and a screwdriver in their attaché cases. No attempt is made to carry out maintenance work, but a minor adjustment to an appliance often creates a good impression, and tends to make the consumer more receptive to suggestions.

During their visits they check and bring up to date the inventory of appliances. Each man normally measures up materials for orders received and thus saves a visit on the part of the district inspector. The average number of effective calls per man per day is 20. The hours of duty are 8.45 a.m. to 5 p.m., Monday to Friday, and 12 noon, Saturday, but special appointment calls are often made after hours. (Actually the first hour of the day is spent in the office booking up.) Rated as weekly wage men, they receive no commission or overtime, but are paid for all holidays and sickness. Merit increases are awarded when the annual revision of wages is made. The highest rate of pay at present is £4 per week.

Canvassing has been directly responsible for £105,860 of business, at a cost to the Company, including administration expenses, of £10,466, *i.e.*, approximately 10 per cent. The success that has attended the efforts of the canvassers, and the potential field for business, indicate that more men could be usefully employed on this work. As advantage has already been taken of the most suitable material available, two other means of augmenting this form of sales have been considered:

(*a*) Employment of an outside sales agency.
(*b*) Engaging and training of young men as canvassers.

The employment of an independent sales agency received consideration some time after the Company's own canvassers had commenced operations. The commission cost suggested was in excess of the Company's existing expenses, without its additional service, and no increase in sales was anticipated.

The training of outsiders with selling ability to work solely as canvassers presents few difficulties, but to put such a scheme into practice would involve certain complications. The measuring for material and advising on practical and technical matters would necessitate a follow-up call by a district inspector. It is felt that a system embracing two types of canvassers would result in friction between the men and impair the results. No definite decision has yet been reached.

Cookery Demonstrations and Exhibitions

For nine years the Company has held cookery demonstrations every Tuesday afternoon during the winter months at the local repertory theatre in the centre of the city. The average attendance at each demonstration throughout the session was about 300. From the point of view of numbers this is highly satisfactory, but it is noticed that a large percentage are regular patrons, many of whom are known to have high-grade cookers, and the chief value of the demonstration to the Company lies in maintaining contact. A complete syllabus of the menus is published at the commencement of the session and widely distributed amongst the consumers. Further publicity is given by means of the Press, posters, theatre programmes, etc.

Table 11A.—*Inventory of Domestic Appliances on Consumers' Premises*

On one of the older districts comprising 4,620 ordinary consumers and 8,902 prepayment consumers, mainly of the artisan class.

	Ordinary Consumers.		Prepayment Consumers.	
	Number.	Percentage.	Number.	Percentage.
1	2	3	4	5
Cookers:				
Hired	1,598	34·6	5,597	62·9
Hire purchase	1,367	29·6	2,362	26·5
Consumers	1,068	23·1	373	4·2
Total	4,033	87·3	8,332	93·6
Fires	1,744	37·7	1,607	18·1
Consumers using fires	1,188	25·7	1,368	15·4
Geysers	1,642	35·5	1,248	14·0
Other water heaters	515	11·1	493	5·5
Wash boilers	2,614	56·6	4,510	50·7
Boiling rings	306	6·6	172	1·9
Lighting	875	18·9	3,856	43·3
Electricity:				
Lighting	3,737	80·9	5,027	56·5
Cooking	331	7·2	438	4·9
Heating	588	12·7	468	5·2
Water heating	581	12·6	613	6·9

Table 11B.—*Inventory of Domestic Appliances on Consumers' Premises*

On a district covering houses of all types, with more than the average of new property, comprising 5,553 ordinary consumers and 7,069 prepayment consumers.

	Ordinary Consumers.		Prepayment Consumers.	
	Number.	Percentage.	Number.	Percentage.
1	2	3	4	5
Cookers:				
Hired	1,525	27·5	3,668	51·9
Hire purchase	1,951	35·1	2,258	31·9
Consumers	1,355	24·4	330	4·7
Total	4,831	87·0	6,256	88·5
Fires	2,216	39·9	848	12·0
Consumers using fires	1,352	24·4	677	9·6
Geysers	3,650	65·8	2,534	35·8
Other water heaters	884	15·9	401	5·7
Wash boilers	3,365	60·6	4,471	63·2
Boiling rings	398	7·1	265	3·8
Lighting	520	9·3	1,494	21·1
Electricity:				
Lighting	5,011	90·3	5,570	78·8
Cooking	589	10·6	715	10·1
Heating	1,437	25·9	873	12·3
Water heating	863	15·5	881	12·4

Cookery competitions are held in conjunction with the demonstrations. To encourage new competitors the competitions are arranged in three grades. Competitors winning a first prize in the third grade must in future compete in the second, whilst the first-prize winner in the second grade thereafter competes in the first grade. First-grade competitors winning three first prizes in a session are debarred from further entries during the session. In conjunction with a local flour manufacturing company, about a hundred cake baking competitions are arranged annually, mainly in church halls throughout the city, the Company providing prizes for cakes baked in gas ovens. A recent competition confined to users of gas cookers produced 1,151 entries.

From September to April, exhibitions of gas apparatus and cookery demonstrations are held in local halls throughout the area of supply. A complete programme of the exhibitions is circulated to consumers and a further invitation is sent to the consumers in each particular district as the date approaches. It is noticeable that the popularity of the exhibitions varies considerably in different districts. Experience shows that the better the locality the larger the attendance. The type of hall also has an influence on the numbers. Space is taken for similar purposes at suitable trades exhibitions. For many years Bristol has successfully organized two "Homes" exhibitions annually, one in March and the other in September, but last year one was omitted and the attendance at the other was considerably below that of previous years. The value of these exhibitions appears to have diminished by reason of the frequency with which they take place. By mutual agreement, gas and electricity displays, which were once features of the exhibitions, have been reduced to more moderate proportions.

TABLE 12.—*Data Relating to Demonstrations, Competitions, etc., during the Year 1938*

—	Number.	Attendance.
1	2	3
Cookery demonstrations in Bristol Gas Company's theatre	55	3,618
" " " the repertory theatre	23	6,761
" " " district halls	219	11,248
Cake competitions	115	—
Exhibitions	4	80,841
Film displays	2	851

HOME SERVICE SECTION

In 1935, the Home Service Section was established to obtain and maintain a close contact with housewives. The personnel consists of a lady secretary with an assistant and the chief demonstrator with her qualified staff of six. The Section is housed at the Head Office and the demonstration theatre has a well-equipped library dealing with domestic science subjects. The section's activities may be enumerated as follows:

(i) To give lectures and demonstrations to organized parties in the Company's own demonstration theatre.
(ii) To organize lectures, demonstrations, competitions for women's meetings, etc.
(iii) To provide courses of cookery lessons for business girls, domestic servants, welfare centres, clinics, etc.
(iv) To offer advice and arrange private demonstrations on consumers' premises.
(v) To supply recipes and complete menus.
(vi) To keep in close contact with the Board of Education with special reference to the domestic science centres.
(vii) To advise on kitchen planning.
(viii) To arrange conducted visits to the showrooms and Works of the Company.
(ix) To keep enrolled members posted with suitable literature.

Today the membership is nearly 7,000.

The demonstrators carry out cookery tests on all new cooking apparatus before it is offered for sale and follow up the sale of cookers with a personal call to ensure complete satisfaction. The area, for this purpose, has been divided into six districts with a demonstrator allocated to each.

TABLE 13.—*Activities of the Home Service Section During the Year 1938*

—	Number.	Attendance.
1	2	3
Conducted visits to the showroom	118	2,703
Evening classes for business girls, etc.	4	61
Courtesy calls after a cooker is purchased	6,142	—

Everything is done on a personal basis. The vague phrase "a demonstrator will call" is never used. By keeping the name of the demonstrator before the consumer it is possible to work on friendly and intimate terms. They are not looked upon as saleswomen and are freely invited to consumers' houses on private and festive occasions. It is considered to be a most successful form of propaganda.

EDUCATION

Attendance at approved afternoon and evening classes is compulsory for all boys or trainees entering the service of the Company. The parent or guardian of every boy is required to sign an agreement to this effect at the time of engagement. The head of the section decides what classes the boy shall attend, and a complete training course is mapped out. The Company pays the class fees in advance and deducts them from the students' wages at a fixed rate per week. The whole of the amount deducted, together with any examination fees which may have been paid by the student direct, is refunded at the end of the session to all students who complete 75 per cent. of the total attendances and sit for the examination. Monthly reports of attendances are obtained from the technical college and/or education authority. In the case of students taking officially approved correspondence courses, the fee is paid by the student in the first instance and repaid by the Company at the end of the course, if the student has sat for the examination.

The Merchant Venturers' Technical College in the city is the principal training centre and provides technical, practical and commercial courses for both day and evening students. The college is administered by a committee composed of representatives of the Society of Merchant Venturers, Bristol University and the Bristol Education Committee. These three bodies, together with the Board of Education, meet the cost of maintaining the College. Although the College is well equipped with engineering workshops, the practical gas fitting classes are held at the Company's Fittings Section, under the auspices of the College.

The showroom staff, together with outdoor salesmen, must take the Gas Engineering (Supply) Course. The College Authorities have no difficulty in recruiting sufficient teachers from the Company's staff for the various technical and practical courses. Lectures and sales talks are given to each of the following groups individually one evening a month during the winter months:

(*a*) Gas fitters and mates.
(*b*) Prepayment collectors and meter readers.
(*c*) Foremen, inspectors, salesmen.

AIR RAID PRECAUTIONS

Since the inception of the Public Services Section of the city's organization in 1936, the Company has been represented on the committee responsible for arrangements to deal with damage from air raids. A scheme has been drawn up whereby in the event of hostilities composite squads of trained men from each of the Public Service Authorities will act as observers (not to be confused with the National Service observers). The City Engineer has arranged throughout the city a number of district depots from which these squads will operate Information of damage to roads will be passed by A.R.P. headquarters direct to the nearest observers' depot. Transport will stand by to convey the observers, excavators (provided by the City Engineer) and emergency outfit to the site. The observers will ascertain if their respective services have been damaged, carry out such emergency work as may be possible prior to decontamination, and report conditions to their own Undertakings.

The Company is providing three main or service layers with each squad. In the event of damage to the Company's

property, one will make contact with the Mains Section whilst the other two attempt to deal with the situation on the spot. Asbestos balls for pushing into fractured pipes where mains are on fire and puddled clay for temporarily sealing fractures form part of the emergency outfit stored at the depots. More permanent repairs will be effected by the Mains Section after decontamination, where such is necessary, has been carried out.

Additional valves are being fitted on mains throughout the area, to enable supplies to be diverted and/or isolated where necessary. The normal stock of fittings and pipes has been increased. Key plans of all valves and siphons, together with a number of loose leaf books showing sketches with full details of sizes, actual positions, etc., have been prepared. Photographic reproductions (half-size) have been made of maps and drawings.

Other details may be summarized as follows:

Maintenance of supplies

Arrangements have been made to by-pass certain sections of manufacturing plant, should the need arise.

Protection of workers

A supply of respirators, decontamination clothing and a few fireproof suits has been provided.

Arrangements have been made in all sections to protect key men who must remain on duty.

Shelters have been prepared in all sections, so far as peace time conditions admit; these can be completed in a short time with materials on site.

Instructions to be followed in the event of an air raid are ready to be posted in all sections.

First Aid Arrangements

Suitable rooms have been provided in all sections for first aid posts.

Adequate first aid equipment is provided, including materials for dealing with gas bomb casualties.

The Company has its own Division of the St. John Ambulance Association with members in each section who have been trained in A.R.P. first aid.

Fire Precautions

Sand and clay dumps, also chemical and foam type extinguishers, are provided at selected points in all sections.

Barricading of buildings containing inflammable stores has been arranged.

Decontamination of Material

A number of men in each section have received decontamination training.

Adequate supplies of bleaching powder have been provided.

Non-Ferrous Metals and the Gas Industry

Communication No. 210

by

HAROLD MOORE, C.B.E., D.Sc.

(Director),

and

E. A. G. LIDDIARD, M.A.

(Assistant Research Superintendent, British Non-Ferrous Metals Research Association).

INTRODUCTION

The division of metallurgy into ferrous and non-ferrous is economic rather than scientific, since about 90 per cent. of the world production of the metals on a weight basis is iron. Iron is not the most commonly occurring metal in nature, however, and if silicon is omitted, the most common metal is aluminium.

TABLE 1.—*Percentage Composition of Earth's Crust*†

1	2	3	4
Oxygen	46·59	Nickel	0·02
Silicon	27·72	Copper	0·01
Aluminium	8·13	Tungsten	0·005
Iron	5·01	Zinc	0·004
Calcium	3·63	Lead	0·002
Sodium	2·85	Tin	0·000*
Potassium	2·60	Silver	0·00000*
Magnesium	2·09	Gold and platinum	0·000000*
	98·62		

* indicates the place of the first significant figure.

Iron owes its preponderance in the metallurgical field to its comparative abundance, to the ease with which it can be reduced from its ores to the metallic state, to its strength, and to the wide range of materials with differing properties which can be obtained from alloys of iron and carbon, etc. Non-ferrous metals range between two extremes, namely, those which are easy to reduce from their ores and are scarce, *e.g.*, gold, silver, platinum, and those which are abundant but difficult to reduce, *e.g.*, aluminium and magnesium.

The comparative output of the more common non-ferrous metals in 1937 is shown in Table 2, and it will be seen that the ratio of ferrous to non-ferrous metals is approximately 16: 1.‡ Up to 1924 this ratio of ferrous to non-ferrous metals was about 20: 1 and the comparative increase in production of non-ferrous metals may be taken to indicate their growing importance. When it comes to value there is a totally different picture. The total value of non-ferrous metals produced, omitting the precious metals, is very nearly half that of iron.

On the grounds of cost alone there is ample justification for the preponderance of ferrous metals in constructional work. It is only when iron or steel fail in a particular application that use is made of a non-ferrous metal. In surveying the non-ferrous metals from the point of view of the Gas Industry, it is proposed to concentrate on the six which are most common, aluminium, copper, lead, nickel, tin and zinc. In this Paper the expression "non-ferrous metals" is to be taken as meaning these six.

TABLE 2.—*Metal Production and Values, 1937*

——	Production, Thousand Tons.	Price* per Ton.	Value, £1,000.
1	2	3	4
Pig iron and ferro-alloys	102,000	£ s. d. 5 10 0	£ 561,000
Non-ferrous metals:		£ s. d.	£
Aluminium	495	100 0 0	49,500
Copper	2,290	40 0 0	91,600
Lead	1,650	16 5 0	26,800
Magnesium	30	200 0 0	6,000
Nickel	130	180 0 0	23,000
Tin	197	192 0 0	37,800
Zinc	1,610	16 0 0	25,800
Total non-ferrous metals	6,402		260,500

* London price at 31st December, 1937.

Ratios—Pig iron, etc. to non-ferrous metals .. Quantity, 16 to 1
Value, 2·15 to 1

PROPERTIES OF NON-FERROUS METALS

The non-ferrous metals differ most strikingly from iron or steel in their greater resistance to atmospheric corrosion. Zinc is the least resistant of the six to corrosion by normal

† Clarke, F. W., and Washington, H. S. *U.S. Geol. Survey Prof. Paper*, 1924, **127**.

‡ It should not be overlooked that the figure of 102 mill. tons for pig-iron and ferro-alloys includes substantial amounts of ferro-manganese, ferro-chromium, etc., and that pig iron ordinarily contains between 90 and 95 per cent. of iron, whereas the figures for the non-ferrous metals are for approximately pure metals.

atmospheres, yet its average rate of penetration by an outdoor atmosphere is about one-tenth that of mild steel. The inherent tendency of iron and most of its alloys to rust when exposed to atmospheres which are only mildly corrosive puts iron and steel at a considerable disadvantage as compared with non-ferrous metals from the point of view of appearance, as well as limiting their service life.

Apart from this high resistance to corrosion these non-ferrous metals have useful properties not possessed by iron or steel. All may be used as protective coatings for other metals, tin and zinc in particular being essential for the protection of steel in certain uses of great importance. Low melting point is the basis of other applications and the low specific gravity of aluminium is its most obvious merit. Ease of working and of machining are general characteristics. An enormous range of properties is found in the great number of industrially used alloys of the selected non-ferrous metals. The capacity of most of these metals and their alloys for retaining an attractive appearance in many conditions of use, if given a suitable finish, is not to be overlooked. Indeed, the properties of the non-ferrous metals and their alloys are so diverse that it is best to consider each of them separately. Before doing this, something might be said about methods of fabrication in so far as they differ from those used for iron and steel.

METHODS OF FABRICATION

Die Casting

The casting of metal into a permanent mould, *i.e.*, one which can be used over and over again, is particularly suited to the mass production of articles from metals with a relatively low melting point, such as aluminium, zinc, and their alloys. The mould is made of alloy steel or cast iron and is machined to give a casting of exactly the required dimensions. The molten metal may be introduced into the mould under pressure or by gravity, and intricate shapes and thin sections can be cast with excellent definition and in most cases requiring little or no subsequent machining. Composite die castings can be produced with inserts of another metal of higher melting point.

Extrusion

This is a cheap and efficient method of manufacturing rods, tubes and long lengths of specially shaped sections which are sometimes quite intricate. The metal is raised to a temperature at which it is soft and plastic, placed in a heated massive strong container and then forced through a die of the required shape.

Electrodeposition

Metals can be deposited both from their salts and from molten electrolytes by the passage of an electric current. This phenomenon is applied both in the extraction and refining of metals, and in electroplating, which is among other things a method of protecting baser metals against corrosion.

Hot Dipping

One of the most important uses of some non-ferrous metals is as a protective coating on steel, and the most economical method of applying a coating is by dipping the steel into a molten bath of the non-ferrous material. For use as a hot-dipped coating, a metal must have a low melting point, together with a capacity for alloying with the basis iron.

CORROSION IN THE GAS INDUSTRY

Since the most striking advantage of non-ferrous metals is their resistance to corrosion, some indication of the conditions in which this property is likely to be useful in the Gas Industry seems desirable. Corrosion in the Gas Industry may be of five types:

(i) Atmospheric.
(ii) Soil corrosion.
(iii) Corrosion by gas during distribution.
(iv) Corrosion by products of combustion of gas.
(v) Corrosion by water in gas-heated domestic appliances.

Atmospheric Corrosion

The relative resistance of ferrous and non-ferrous metals to atmospheric corrosion has been the subject of a number of investigations, including extensive work by the British Non-Ferrous Metals Research Association. The estimated corrosion of various metals and alloys after one year's exposure to the atmosphere at Manchester is shown in Table 3.

Table 3.—*Estimated Corrosion of Certain Metals and Alloys**

Material.	Life of an 18 S.W.G. Sheet (0·048 In.), Years.
1	2
Lead	160
Copper	140
Nickel	96
70/30 brass ..	75
Zinc	60
Cast iron	12
Mild steel	6

Aluminium and tin exposed to the atmosphere at Birmingham gave a rate of corrosion of approximately one-half and one-third respectively of that of copper at Manchester. Although the results are not directly comparable, they indicate that both aluminium and tin would stand very high in Table 3.

One of the most commonly used methods of combating atmospheric corrosion of iron or steel is to apply a coating of non-ferrous material, and in this connexion it is important to consider whether the coating metal is anodic or cathodic to the basis metal; that is to say, when the basis metal and the coating are together exposed to an electrolyte, *e.g.*, moisture, whether the coating metal forms the anode or cathode of the resulting local cell. If the coating metal is cathodic, whenever the coating becomes perforated the basis metal corrodes at an accelerated rate. On the other hand, if the coating metal is anodic the basic metal is protected by sacrificial corrosion of that coating. It follows, therefore, that if a metal cathodic to iron is to be used the coating must be continuous and of adequate thickness; and the conditions of service must be such that no damage causing perforation of the coating is likely to take place. Zinc and cadmium are anodic to iron, aluminium is sometimes anodic and sometimes cathodic, depending on corrosive conditions, while tin, lead, copper, nickel, and chromium are cathodic. The good resistance of zinc to atmospheric attack, coupled with its anodic behaviour in contact with iron, accounts for the fact that the use of zinc in galvanizing absorbs nearly half the total output of this metal.

If, in addition to a useful service life, a pleasing finish is desired, one may take advantage of the good appearance of aluminium and use the metal in solid form, or use a basis metal which is itself resistant to corrosion, *e.g.*, copper or brass, and superimpose by electrodeposition an undercoating of nickel followed by chromium plating. In most coatings of this type the resistance to general corrosion is the function of the nickel undercoating and the chromium coat is often a relatively thin flash to prevent tarnishing. A thin chromium coating is usually non-continuous and contains cracks. It is important, therefore, to ensure that the nickel coating is of adequate thickness to obtain a satisfactory service life. The British Non-Ferrous Metals Research Association has been responsible for the development of a test (the B.N.F. Jet Test†) which enables the thickness of most electrodeposits to be determined locally without destruction of the plated article. It is now possible to determine the minimum thickness of deposits and thus ensure compliance with specifications and good service from plated articles.

Two of the most important factors in atmospheric corrosion are the presence of sulphur dioxide and the moisture content of the air. The corrosion of iron, copper, nickel, and zinc is enormously accelerated by the presence of sulphur dioxide under conditions in which condensation can occur.‡ It is desirable to eliminate sulphur in all forms from the manufactured gas so that corrosion by products of combustion may be minimized.

Soil Corrosion

Corrosion by soil is a serious factor in the distribution of gas. The mechanism of soil corrosion is complex, and much

* Hudson, J. C., "Field Tests on Ferrous and Non-Ferrous Materials", *Proc. Chem. Eng. Group, Soc. Chem. Ind.*, 1937, **19**, 30.

† Clarke. S. G., "The B.N.F. Jet Test for Local Thickness Measurement of Nickel and Other Coatings". *J. Electrodep. Tech. Soc.*, 1937, **12**, 1–18, 157–168. (British Patent No 476,876.)

‡ Vernon, W. H. J., "The Atmospheric Corrosion of Metals", *Proc. Chem. Eng. Group, Soc. Chem. Ind.*, 1937, **19**, 14.

work is needed to establish the relative resistance of various materials to differing types of soil. The British Non-Ferrous Metals Research Association is at present investigating the soil corrosion of copper, lead, and some lead alloys, and is collaborating with the Institution of Civil Engineers in connexion with a more general investigation on soil corrosion. There is one factor, however, the importance of which has only recently been realized. The graphitization of cast iron mains has recently been shown by H. J. Bunker* and others to be brought about by the action of sulphate-reducing bacteria in certain soils. These bacteria reduce sulphates in the soil and produce hydrogen sulphide, releasing at the same time oxygen, which becomes available for corrosive attack. This is mentioned here because these same bacteria can be active in the water seal of gasholders and the reduction of sulphates present in the water gives rise to traces of hydrogen sulphide in the gas. A process developed by the British Non-Ferrous Metals Research Association for the inhibition of sulphate-reducing bacteria is covered by British Patent No. 497,829.

A factor which increases the importance of soil corrosion is the rising cost of resurfacing roads, etc., after replacement of failures in buried mains and supply pipes. The initial cost of the more resistant non-ferrous metal pipe may therefore be more than balanced by the saving in upkeep charges.

Corrosion by Gas During Distribution

In general, this is not a serious problem and gas for distribution can be conveyed in ferrous materials. When corrosion does occur, it is due to moisture in the gas acting concurrently with free carbon dioxide.

Corrosion by Products of Combustion of Gas

Corrosion by products of combustion is most severe where the part being heated remains at a temperature below 100° C. and condensation takes place. This condition applies in most instances where gas is used for domestic purposes and particularly in the case of water heating.

Corrosion by condensed products of combustion has been investigated by the Joint Research Committee of The Institution of Gas Engineers and the results of their investigations are contained in a number of reports.† They show that the corrosion produced on iron, zinc, and copper increases rapidly with the rise of sulphur content of the gas. The corrosion of aluminium increases only slightly, while the corrosion of lead decreases with rise in sulphur content. These effects can be explained by the known behaviour of non-ferrous metals exposed to atmospheric corrosion involving sulphur dioxide. With lead the product of corrosion is the practically insoluble lead sulphate, which therefore forms a film protective against further attack. In the absence of the oxides of sulphur, lead nitrate is formed which is much more soluble than the sulphate. Tin is also resistant to condensed products of combustion even when sulphur is present. The remedy for corrosion by products of combustion lies primarily with the gas manufacturers themselves, who should so far as is practicable remove all traces of sulphur from the gas, or, where this is impracticable, those parts of water heating appliances, etc., exposed to the products of gas combustion should be coated with an adequate thickness of tin, lead, or tin-lead solder.

Corrosion by Water in Gas-Heated Domestic Appliances

The most commonly used materials for containing heated domestic waters are copper and galvanized iron. For many waters galvanized iron is quite satisfactory, but corrosion of galvanized iron by water is greatly accelerated by minute traces of copper in solution, and for this reason it is recommended that, unless previous experience has shown that copper and galvanized iron can safely be used together with a particular water, the combination should be avoided. Galvanized iron is the cheaper material, and is often perfectly satisfactory, but the all-round resistance of copper, together with its high thermal conductivity and ease of fabrication, makes it very suitable for this purpose and sometimes renders it more economical in actual use.

* *Cf.* Bunker, H. J., "The Role of Sulphate-Reducing Bacteria in Metallic Corrosion". *Proc. Brit. Assoc. Refrig.*, 1936–37, **35**, 152–155.

† *Trans. Inst. Gas. Eng.*, 1934-35, **84**, 246; 1935-36, **85**, 167; 1936-37, **86**, 58.

INDIVIDUAL CHARACTERISTICS AND APPLICATIONS OF NON-FERROUS METALS

The principal characteristics of the most important non-ferrous metals and the manner in which these characteristics are turned to account in particular applications in the Gas Industry may now be considered. No attempt is made to cover all possible uses of the metals: a selective account is given of some of the most important applications and the reasons for them. Attention has been turned to the distribution of gas rather than its production.

Aluminium

The outstanding characteristics of aluminium are its lightness, corrosion-resistance, high thermal conductivity (about 60 per cent. of that of copper), high reflectivity, and its capacity for forming a continuous and refractory oxide coating. These properties find application in varying degrees in the Gas Industry. The lightness of aluminium obviously gives it the widest field of application in transport, aeronautical engineering, and for reciprocating parts in machinery, but is of little importance in the Gas Industry.

In some circumstances the corrosion-resistance of aluminium is surprisingly good. Aluminium is less affected by sulphurous atmospheres than most non-ferrous metals, and is remarkably resistant to atmospheric corrosion in all but marine atmospheres. Its resistance to sulphurous atmospheres makes it useful for resisting the products of combustion of gas, but is lowered if condensation of moisture takes place at the same time. The high reflectivity of aluminium makes it useful as a reflector for both heat and light. It is used for reflectors for portable heaters. A recent development is the Brytal treatment,* for the production of reflectors, in which the surface of aluminium is brightened by an electrolytic process and is subsequently treated to form a continuous protective oxide film which is very transparent and prevents deterioration of the bright reflecting surface in the atmosphere. It is claimed that aluminium treated by the Brytal process will resist sea coast atmospheres. In the form of paint, aluminium can be used to promote constancy of temperature in gasholders, etc., since solar heat is reflected while heat radiation is minimized, and thus the temperature conditions inside the gasholder remain more constant with fluctuations in the atmospheric conditions. In the same way aluminium paint forms a useful and pleasing finish to furnaces and other heating appliances since the heat loss is diminished owing to the low emissivity of the aluminium surface.

The uniform and continuous layer of refractory oxide which forms on the surface of aluminium is the cause of its high resistance to atmospheric corrosion, and this property is utilized in the process of calorizing, which consists in coating iron or steel with aluminium by a cementation process or sometimes by hot dipping. A surface layer of aluminium-iron alloy is formed by this process, and material so treated shows a remarkable resistance to oxidation since the alumina skin which forms on the surface of the iron-aluminium alloy resists further attack. Calorized parts are used in grill frets in gas cookers and have been suggested for gas burners. In industrial applications calorized parts are useful where heat resistance is required, for example, as containers for articles undergoing heat treatment or case hardening in gas-fired furnaces.

The uses of aluminium are developing rapidly, and the possibilities of this metal and its alloys for wider application are considerable. The resistance of aluminium to domestic waters, for example, has not yet been fully explored, and the feasibility of using soft aluminium tubes for the conveyance of gas in the house and as a material for the construction of water heating systems is now receiving attention.

It is, however, at a disadvantage in one respect when compared with copper. Owing to its refractory oxide coating, aluminium is difficult to solder satisfactorily, and in consequence the jointing of tubes (so simply done in copper using capillary solder joints) and the fabricating of thin sheet and finned apparatus, such as is required for water heating, is rendered more difficult. There is, however, no reason why these drawbacks should not be overcome, and new develop-

* The total reflectivity of light from a lacquered silver plate is 89·8 per cent.; from Brytal on commercial aluminium, 76·8 per cent.; and from Brytal on super-pure aluminium, 84·1 per cent.

ments in the use of aluminium and its alloys in the Gas Industry may be anticipated.

Copper

Copper has good resistance to corrosion and is readily fabricated and jointed. These properties make copper pipe a particularly suitable material for gas distribution. There has been a considerable development in this direction in recent years, mainly in the United States; in Great Britain a notable example is the Nairn Gas Light Company, Limited, which, since experiments made in 1927, has used only copper for gas service pipes.

The movement towards the use of copper for gas distribution arises from the corrosion of cast iron or steel gas mains. This varies in intensity according to the nature of the soil in a particular area. In some soils it can be exceptionally severe (as is frequently the case in the United States), necessitating renewal of mains and services at comparatively short intervals of time. For many soils copper immediately suggests itself* as a less corrodible material. After various trials, installations totalling several hundred miles in length have been made in the United States. Very encouraging reports have come from the Gas Companies concerned; the life of the mains and services has increased and there has been a considerable reduction of renewal work. In this country, J. Barker has reported favourably on results obtained by the Nairn Gas Light Company, Limited. Suitable jointing devices are available, *e.g.*, compression joints, etc. Copper pipe is more easily handled and worked than iron or steel pipe.

The cost of providing copper pipe, *i.e.*, the price of pipe plus laying costs, is somewhat higher than for iron or steel, but an overall saving is claimed owing to a reduction in upkeep and renewal charges: in the case of certain soils in the United States which are highly corrosive to iron and steel the results seem very striking indeed.

A number of services ancillary to gas use considerable amounts of copper, in particular geysers and other water heaters. These have the water heating unit made of copper either as finned tubing or other construction to allow of a high rate of heat transfer, and the surrounding bodies are generally made from copper sheet. The heating tubes, bodies, and flues are "tinned" (varying proportions of lead being present) to protect the copper from the action of the sulphurous gases present in the combustion products. For such purposes the high thermal conductivity of copper, second only to that of silver, is an advantage.

Brass and Bronze

The solid solution of zinc in copper called alpha brass can contain up to about 38 per cent. of zinc at atmospheric temperatures. The alpha brasses have a degree of plasticity in cold working operations not attained by other alloys which are at the same time cheap enough and strong enough to serve as generally useful engineering materials of construction.

They are used for a great variety of articles, and all the established methods of working—rolling, drawing, pressing, stamping, spinning—are employed in making the intermediate and final products. Two of the compositions most commonly employed are 70 per cent. copper, 30 per cent. zinc (cartridge brass or 70/30 brass), and 63/37 brass. A group of brasses containing both the alpha and beta solid solutions is typically represented by the 60/40 mixture (Muntz metal). The feature which distinguishes these mixed alpha plus beta brasses from the simple alpha type is the high plasticity at red heat which disappears on cooling, *i.e.*, these alloys can readily be worked hot by stamping, rolling, extrusion, etc., but are not suitable for severe cold-working operations, although they may be considerably strengthened by limited cold-working, *e.g.*, drawing. This material is suitable for machining and the addition of a small amount of lead markedly improves free-cutting properties. Latterly investigations have been made on the use of additions of selenium, tellurium, or sulphur instead of lead, for conferring free-cutting properties on copper and its alloys.

For special purposes, brasses are used containing additions of other elements to increase the strength or improve other properties.

In general, brasses are cheaper, stronger, and harder than copper, and have good casting properties. Brass is used in the cast or hot-pressed form for taps, injectors, tube connexions, thermostat heads, governor bodies; as pressings or spinnings for burner orifices, air control washers, decorative fittings; as tube for thermostat couples and connecting pipes; as gauges for eddy filters and dust filters in thermostats and valve fittings generally; and in numerous meter parts, etc. Brass is readily jointed by soldering or brazing, and can be finished by nickel and chromium plating.

Before its causes and means of prevention were understood, "season-cracking" was a not infrequent trouble in brass. It was liable to appear in cold-worked brass after a short or long period of use, sometimes several years, and to result in complete failure of the object. Season-cracking in brass has been shown to be due to the combined action of stress and of selective chemical attack localized at the crystal boundaries. As a rule the stress is internal, *i.e.*, not caused by any applied force, and the attacking agent is ammonia, very slight traces of which in the atmosphere are sufficient to initiate cracking at the crystal boundaries if the surface of the brass is in tension.

The prevention or removal of the internal stress is a complete remedy. Internal stresses commonly arise in the course of cold-working, but manufacturing processes can usually be controlled to avoid the development of serious internal stresses in cold-working operations. There are certain operations, however, such as spinning and some kinds of drawing, in which it is difficult or impossible to prevent the development of high internal stresses, and the presence of such stresses can only be detected by destructive tests. If a brass article in a state of internal stress is heated for a short time at 250° to 300° C., the stresses are lowered to a safe limit and the danger of season-cracking removed, without any injury or loss of strength of the brass. Such "low-temperature heat-treatment" is frequently applied to brass articles in which the presence of internal stress and consequent liability to season-cracking are suspected, and is always an effective remedy.

Gas and its products of combustion appear to be capable of initiating season-cracking in stressed brass, and it is therefore important to ensure that brass articles and components used in connexion with gas appliances are free from internal stress.

The copper-tin alloys (tin bronzes) are also of commercial importance. They contain commonly up to 10 or 12 per cent. of tin, and when phosphorus is used as a deoxidizing agent in their production they are known as phosphor bronzes. They are of value in spring construction; thus the 10 per cent. alloy cold-rolled or drawn to spring temper will withstand stresses in the neighbourhood of 40 tons per sq.in. without appreciable plastic deformation. Bronzes frequently contain additions of zinc, *e.g.*, Admiralty gunmetal, which is copper/tin/zinc, 88/10/2.

The addition of tin to copper increases the tensile strength, hardness, wear-resistance, and frictional-resistance. Phosphor bronze, gunmetal, and leaded bronzes constitute an important and valuable group of bearing metals.

Lead

The principal characteristics of lead are high specific gravity, great ease with which it can be worked cold, and outstanding resistance to most forms of corrosion. On the debit side must be placed its very low strength and, in the case of the pure metal, low resistance to fatigue. Lead pipes can be supplied in coil form in long lengths, which cuts down the amount of jointing required.

Lead pipe has long been used in the Gas Industry for the conveyance of gas, not only in the domestic household but in many cases from the gas mains to the meters, and its use still continues. There was a phase some few years ago when the use of lead pipe seemed to decrease and substitutes were utilized in certain districts. There is evidence, however, that the use of lead is now increasing.

The low fatigue limit of lead renders it liable to fail by intercrystalline cracking under service conditions where alternating stress, sometimes merely due to vibration, can take place. Recent work has been directed to the improvement

* For example, in certain highly alkaline soils in Southern California the life of steel pipe is short, whereas the rate of corrosion of copper is very slow.

of fatigue properties without serious diminution of the plasticity, regarded as so essential a property of lead, by the addition of alloying elements. For example, a small quantity of tellurium will raise the fatigue limit from ± 0·18 to about ± 0·5 ton per sq.in., while alloys containing cadmium and tin or cadmium and antimony (B.N.F. Ternary alloy) have fatigue limits up to about ± 0·75 ton per sq.in. Lead pipe can easily be bent to fit any particular installation, and extensive use is made of lead as a means of connecting meters, geysers, stoves, etc. Although the softness and flexibility of lead pipe is in many cases an advantage, there are conditions in which lead is too soft, and in future it may be found that lead alloys, which are considerably harder than the pure metal but which still have sufficient plasticity to be bent and shaped, and supplied in long coils, will come into use in the Gas Industry. The appearance and tarnish-resistance of lead pipe can be improved by the use of a tin wash on the outside, as in the case of " compo " pipe.

Nickel

Nickel forms a large range of alloys, both ferrous and non-ferrous, having wide industrial applications. It alloys easily with iron, the alloys being characterized by high strength. Further addition of chromium also imparts corrosion-resistance, as, for example, in the well-known 18/8 austenitic stainless steel (containing 18 per cent. chromium and 8 per cent. nickel), which finds numerous applications in the chemical and allied industries. Alloys containing higher percentages of chromium and nickel (35 to 75 per cent. nickel plus chromium) are essentially heat-resisting alloys.

Among the non-ferrous alloys of nickel, reference may be made to Monel metal (67 per cent. nickel, 29 per cent. copper, with small amounts of iron and other metals); cupro-nickel; nickel-silver (copper-zinc-nickel); and nickel-chromium. Monel, a silvery-white alloy combining useful engineering properties with ease of fabrication and resistance to a range of corrosive media, finds numerous applications in gas manufacture. For example, it is used in sludge run-off chutes in coal washing plants, and for the perforated screens used in the removal of coke dust from quenching water; in pump rods for handling hot tar; in handling ammonia (pump rods) and ammonium sulphate; in plant for light oil refining, etc. In recent years a number of alloys derived from Monel and having special properties have appeared, *e.g.*, K-Monel, containing 2·75 per cent. aluminium, and silicon Monel, containing 3 per cent. silicon; both of these can be hardened by heat treatment.

The alloys of nickel and chromium with 80 per cent. or more of nickel are resistant to oxidation at high temperatures (up to about 1,150°C.) and retain a relatively high proportion of their strength. In flueless gas fires it is the practice to incorporate a metal coil in the fire, which is supported by a perforated metal strip. This coil gives an effect similar to an electrically heated radiant fire and has to withstand high temperatures. It is usually made of 80/20 nickel-chromium. Such alloys cannot be used, however, in contact with hot gases high in sulphur. It may be mentioned that in addition to their strength and good oxidation-resistance at high temperatures these nickel-chromium alloys also have high electrical resistance, and are therefore used as electrical resistors.

An interesting property of iron-nickel alloys is that in the neighbourhood of 36 per cent. nickel content the coefficient of thermal expansion becomes zero or very low (for a limited range of temperature), the length being practically invariable for ordinary changes of temperature. These alloys, known as Invar, find application in the thermostatic regulation of gas appliances.

Nickel may be readily electrodeposited on other metals. The coating is attractive in appearance and resistant to atmospheric corrosion in the absence of sulphur dioxide. For satisfactory service behaviour nickel should always be used as an undercoat to a final deposit of chromium (see page 9). These electrodeposits are used as finishes on numerous gas appliances.

Tin

Tin shows good resistance to corrosion, and preserves its attractive appearance. It has a low melting point (232°C.), which renders it easy of application to other metals in the form of hot-dipped coatings. Tinplate (steel with a coating of tin) is used for the cases and some internal constructional parts of ordinary gas meters, a grade with a fairly heavy tin coating of about 4 to 6 lb. per basis box (0·006 to 0·009 mm., or 0·00025 to 0·00037 in., on each side) being commonly employed. Mention has already been made of the use of tinned copper. Gas geysers and other gas heaters and wash boilers are generally made of copper tinned on the inside where the metal comes into contact with the water. Tinning may be done electrolytically or, probably more commonly, by the hot wiping method. Most geysers are made of sheet which is dipped before fabrication.

The grid-and-cover valves used in gas meters are pressure die-castings of tin-antimony alloys. Usually the cover contains rather more tin than the grid, representative compositions being 72 per cent. and 68 per cent. of tin with the rest antimony.

Tin solders find considerable application, of course, for jointing purposes.

Zinc

As has already been indicated, the most important characteristics of zinc are its good resistance to atmospheric corrosion, its low melting point (419°C.), the ease with which it alloys with iron, and its adaptability to the process of die casting.

The major use of zinc in the Gas Industry is as a protective coating on iron; the zinc is usually applied by hot dipping, but may also be electrodeposited. Galvanized sheet is used in a number of light sheet constructions where the corrosive conditions are such as to prevent the use of unprotected iron or steel. It should be emphasized, however, that galvanized iron is not fully resistant to atmospheres high in sulphur dioxide, particularly when condensation is also liable to occur.

The use of zinc as a basis metal for die castings has increased enormously in recent years. This is due largely to the discovery that troubles formerly occurring with zinc-base die-castings are entirely overcome by the use of zinc of high purity. For the production of die castings with adequate strength, aluminium and copper are used as alloying elements, and if the basis metal contains impurities, notably tin and lead, the castings tend to disintegrate on exposure to the atmosphere, particularly with high temperature and high humidity. The production of zinc with a purity of 99·99 per cent. has enabled die castings to be developed with tensile strengths of more than 21 tons per sq.in. and free from the tendency to disintegrate. Complicated pieces of mechanism with inserts of brass for bushings and other wearing parts can be cheaply mass produced in the form of die castings and find application, for example, as meter parts where they resist corrosion by dry gas.

RESEARCH

The present uses of the non-ferrous metals and their alloys in the Gas Industry have been rapidly reviewed and the reasons for their adoption indicated. Although this is not the occasion for more than the briefest mention of metallurgical research, it should be pointed out that many laboratories are constantly engaged in work for the improvement of non-ferrous metal products and the development of new products and processes. The Gas Industry, in common with other industries employing these materials, gains from such developments. In the field of corrosion-resistance, to mention one direction of progress only, the mechanism of attack and its prevention is now far better understood and materials for enduring particular corrosive conditions may be selected with certainty.

The thanks of the Authors are due to members of the British Non-Ferrous Metals Research Association who have supplied information regarding the various uses of non-ferrous metals in the Gas Industry, and particularly to their colleague, Mr. B. Fullman, for the collection of much of the information contained in this Paper and for considerable assistance in its preparation.

Comfort by Gas Heating

Communication No. 211

[Abstract]

HEATING OF DOMESTIC PREMISES

Development of Gas Heating Appliances

In the last ten years gas heating appliances have improved markedly in appearance and performance. Different types of heater have also been developed to give a wider range of performance.

Range of Performance

It is worth noting that gas has two unique properties giving it a valuable advantage over other fuels:

(*a*) A flame can immediately be produced at a temperature of over 2,000° F.

(*b*) A very high maximum heat output is easily available and this output can be regulated steadily by means of a cock or thermostat. A ¼-in. B.S.P. gas pipe can readily supply over 30,000 B.Th.U. per hr., or a ½-in. pipe can supply 150,000 B.Th.U. per hr. This corresponds with 9 to 45 units per hr. of electricity or the heat output of a coal fire burning 6 to 30 lb. per hr

Space Occupied and Capital Cost of the Appliance

The dimensions and appearance of heaters of similar heat output vary considerably to allow for different circumstances of use. There has, however, been a tendency to introduce simple designs in stamped steel with consequent saving of cost. Also, the heat output of a given appliance has often been increased without any appreciable effect on price or efficiency.

Proportion of Radiant to Convected Heat

This proportion varies from about 20 to 1 for a gas fire in a flue to about 0·02 to 1 for a background heater. The following table shows the range covered by typical gas appliances:

Table 2.—*Range Covered by Typical Gas Appliances*

Appliance.	Radiant/Convected Heat.
Flued gas fire	20
Convector gas fire	2
Flueless gas fire	0·8 to 0·3
Radiator	0·3 to 0·1
Convector	0·1 to 0·02

By a combination of suitable types of appliance almost any desired ratio of radiant/convected heat can be obtained.

Ventilating Effect

The ventilating effect of a heater in a room will only vary appreciably from one type of heater to another if the heater is connected to a flue. A flue in a room will also *per se* increase the ventilation compared with a flueless room.

The extra ventilation obtained by using gas fires fitted to a flue may easily exceed 6,000 cu.ft. per hr.

Necessary Heating Requirements

Living Room.—This is the one room in the house in which which a high standard of healthy comfort is essential. It will normally be occupied by sedentary people for at least 8 hours a day, on average, during the heating season.

As the occupants are generally seated and relaxed an open fire is ideal providing a reasonable air temperature is maintained. If the initial air temperature is below 50° F. it will be a long time before the fire can raise this temperature to the required level. It is a familiar experience that rooms heated only by an open fire are, in cold weather, not really comfortable during the first few hours of occupation. The initial air temperature will be below 55° F. on about 140 days each year, below 50° F. for 70 days and below 45° F. for 30 days. Even at an air temperature of 55° F. it is necessary to sit rather close to the fire and if it is desired to use other parts of the room, *e.g.*, when sitting at a table, higher air temperatures are needed.

by

L. W. ANDREW, B.A., B.Sc., M.Inst.Gas E.

and

A. BARRON

(Gas Light and Coke Company).

During cold weather and especially in large rooms independent air heating is desirable so that the initial air temperature is about 55° F. before the fire is in use. In large houses this air heating is often provided by hot water radiators. Such central heating is too expensive to install in a small house and a similar effect can be obtained very cheaply by means of independent flueless convector heaters. These heaters are normally called " background heaters ". A background heater is adequate to provide about one half of the heat requirements of a room and is generally rated at about 2,000 B.Th.U. per hr. for each 1,000 cu.ft. of room space. A fire provides the remaining heat requirements only when the room is occupied.

It is important to realize the analogy between central heating by hot water radiators and by means of background heaters. The low rating of the background heater makes it necessary to use it for long periods if it is to be of value, in the same way that hot water radiators are kept more or less continuously in operation. Apart from the low capital cost of providing air heating by these independent units they have the advantage of the low running cost of a flueless heater. Any possible criticism of condensation, or smell if the gas is of high sulphur content, is most unlikely because of the low rating of the heaters and their use in rooms which are ventilated by means of a flue. If economy is of first importance a flueless gas fire of low gas rate can give comfort during the mild weather, *i.e.*, on about 70 days in a year.

Dining Room.—This room may be the same as the living room but more frequently it is only used for short periods each day for meals and then the occupants are to a great extent shielded from radiant heat from a fire.

A radiant ventilating fire is normally provided although the air temperature should ideally be higher than in the living room. The fire is an advantage if the room is at times used as a sitting room, but there is every advantage in providing additional independent air heating. If extra air heating is not provided the fire should give a high maximum output and be put into operation for some time before the room is occupied.

Again a flueless fire can be used during mild weather.

Desirable Heating Requirements

Kitchen.—This room is of particular importance to the housewife or, under certain circumstances, the maid. The room may be used as a dining room until the evening but except at meal times the occupants will not be sedentary. Casual heat from cooking and of much greater importance from a coke boiler, if this is used for water heating, provides the warmth for the greater part of the day.

A flueless gas fire is desirable to give comfort in the early part of the day and also when the room is in sedentary occupation.

Hall and Landing.—For about 160 days in the year it is expected that these parts of the house will be uncomfortably cool even for non-sedentary people. During the really cold weather, say, 70 days, discomfort will be marked and the extent to which this condition is accepted in small houses is surprising. In larger houses it is common practice to give some air heating by hot water radiators.

A flueless appliance heating largely by convection should be used to give a general heating effect. In practice, however, a heater giving some radiation generally proves more attractive to the occupant. The construction of small houses allows the use of a heater in the hall to increase to a marked extent the comfort over the whole of the house.

The conditions in the hall and the house generally will to a great extent be determined by the amount of heat used during the early part of the day in the various rooms. A warm kitchen, in particular, will have a beneficial effect over the whole of the house.

Bedrooms.—A flue is very desirable in these rooms, in which so much time is spent in a sedentary manner, often

during cold weather with the doors and windows closed. Heating is needed for such short periods that it is uneconomic to raise the air temperature to any marked extent. A radiant fire of high heat output is needed for dressing, etc. If the room is flueless a heater should be used giving the maximum intensity of radiant heat practicable.

Central heating by hot water provides an excellent method of giving a background of heat to the whole house whilst leaving radiant fires to give the final heating in individual rooms. A separate Section of the Paper deals with the possibilities of using gas as a fuel for this purpose.

The following table summarizes the gas appliances suggested for use in different parts of a house and also the appliances which are often used in practice as alternatives:

TABLE 7.—*Suggested Gas Appliances and Alternatives*

Room.	Gas Heaters.		Common Alternatives.
	Ideal.	Satisfactory.	
Living room ..	Fire + air heater	Fire	Coal or coke fire
Dining room ..	Fire + air heater	Fire or flueless fire	Coal, coke or electric fire
Kitchen	Flueless fire	Flueless fire	—
Hall and landing	Flueless fire or radiator	Flueless fire or radiator	Slow combustion stove or oil stove or nothing
Bedrooms ..	Fire	Flueless fire	Coal or electric fire or nothing

The cost of obtaining comfort is so important that some estimate must be given of the comparative running cost of the different methods.

COMPARATIVE RUNNING COST

Coal, Coke and Gas Fires

Figures of comparative cost must take into account the period of usage and the effect of additional air heating. The factors involved are complicated and any figures deduced need checking by practical tests under domestic conditions, but there is sufficient evidence to give some sort of limits of price of gas to show the equivalent cost to solid fuel. The significance of the following factors is much more difficult to assess for solid fuel than for gas:

(i) The closeness to which the solid fuel fire will give the most desirable heat depends on the skill of the user.
(ii) The heat output of the solid fuel fire is variable and periods of overheating and underheating occur.
(iii) The cost of the initial load of solid fuel is high, even if the heating is only needed for a short period.
(iv) If a room is unoccupied for an hour or so it is necessary to "keep in" the solid fuel fire and this heat output is only indirectly useful.

Cost is most important for living room heating and this aspect has been considered independently, and from completely different angles, by M. Fishenden and R. E. Willgress and by W. Davidson and H. Hartley.

Fishenden and Willgress show that in a living room occupied for 16 hours per day a gas fire with gas at 4·3d. per therm is equivalent in cost to a coal fire using coal at 2s. 6d. per cwt., while gas at 3·8d. per therm is equivalent to low-temperature coke at 2s. 3d. per cwt.

Davidson and Hartley show that gas at 4d. per therm will be cheaper for living room use than coal at 2s. 4d. per cwt., and gas at 3d. per therm will compete with normal gas coke at 2s. 1d. per cwt. Gas would in practice be in a more favourable position than that given by Fishenden and Willgress, as 16 hours is an abnormally long period of occupation and the shorter the period of occupation the cheaper is gas compared with solid fuel.

Both the results quoted probably favour solid fuel as it is assumed that the whole of the heat given to the room by each fire is equally useful. In practice it is to be anticipated that with a gas fire the occupant will more nearly approach the most desirable comfort conditions and also that the effect of a variable occupational period will favour gas.

A large number of tests on the 16 in. coal grate have recently been carried out at Watson House and these have been analysed to separate the initial load of coal from the regular loading required to maintain a steady output. Heat outputs were determined "on the floor" by a slightly modified Leeds method using a calibrated thermopile. The 16 in. coal grate is typical of the greater number of living rooms and the following results are averaged from tests on a 16 in. well-type grate and a 16 in. barred grate, each of reputable popular make.

TABLE 8.—*Results of Tests on 16 In. Coal Grate*

Initial Load. Size.	Lb.	Refuelling Rate, Lb. per Hr.	Heat Output in 1 Hr., B.Th.U.	Heat Output in 2 Hr., B.Th.U.	Maintenance Heat Output B.Th.U. per Hr.
1	2	3	4	5	6
Large	14	3½	1,600	11,000	10,500
Average	10	2½	3,000	9,600	6,750
Small..	7	1¾	1,900	6,700	3,750

The average rate of heat output and the initial heat output credit the coal fire with the whole of the heat as useful.

The size of the initial load will affect the heat output reached after reloading, but for practical purposes reloading is assumed to take place as soon as the heat output has dropped to about the same value as the average steady heat output. Considering the average initial load and average refuelling rate it is necessary to refuel after 2 hours.

If the average heat output is taken as typical and satisfactory in practice to the occupant of the room it is possible to calculate the cost of gas to give the same initial heat input to the room before occupation, and the same steady heat input for different periods. The cost of ignition is counterbalanced by the value of the unburnt fuel at the end of the day. The radiant efficiency of the gas fire, on the floor, is taken as 45 per cent.

Table 9 and Figure 3 compare the existing gas and coal fires under different conditions of use.

The figures suggest that for normal living room purposes, the use of gas at 5d. per therm for 8 to 12 hr. is equivalent in cost to coal at 2s. 6d. per cwt. For dining room use, say ¼ hr., gas at 10d. therm is cheaper than coal at 2s. 6d. per cwt. unless the room is preheated to an unusual extent.

In practice, owing to the greater flexibility of gas, it is anticipated that for short period use the gas fire will give greater comfort than the solid fuel fire, and will be relatively rather more expensive than as shown by the figures in Table 9; for long period use the gas fire should again be more comfortable and relatively rather less expensive than the calculated figures.

If additional background heating is employed, by independent air heaters, the initial air temperature will be in-

TABLE 9.—*Comparison of Cost of Gas and Coal Fires under Different Conditions of Use*

Hours of occupation.	1 Hour Preheat by Coal, no Preheat by Gas.				1 Hour Preheat by Coal, and Same Heat Input by Gas.				2 Hr. Preheat by Coal, and Same Input by Gas.			
	Coal (at 2s. 6d. per cwt.), Pence.	Gas (at 4d. per Therm.), Pence.	Gas (at 9d. per Therm.), Pence.	Equivalent cost of gas per Therm, Pence.	Coal (at 2s. 6d. per cwt.), Pence.	Gas (at 4d. per Therm.), Pence.	Gas (at 9d. per Therm.), Pence.	Equivalent Cost of Gas per Therm, Pence.	Coal (at 2s. 6d. per cwt.), Pence.	Gas (at 4d. per Therm.), Pence.	Gas (at 9d. per Therm.), Pence.	Equivalent Cost of Gas per Therm, Pence.
1	2	3	4	5	6	7	8	9	10	11	12	13
1 ..	2·7	0·65	1·4	16·6	2·7	0·95	2·05	11·4	3·30	1·55	3·4	8·5
2 ..	3·30	1·25	2·75	10·6	3·30	1·55	3·4	8·5	3·9	2·15	4·75	7·25
4 ..	4·55	2·45	5·45	7·45	4·5	2·75	6·1	6·6	4·85	3·35	7·45	5·8
8 ..	7·0	4·85	10·85	5·8	7·0	5·15	11·5	5·4	7·6	5·75	12·85	5·3
12 ..	9·4	7·25	16·25	5·2	9·4	7·55	16·9	5·0	10·0	8·15	18·25	4·9
16 ..	11·8	9·65	21·65	4·9	11·8	9·95	22·3	4·75	12·4	10·55	23·65	4·7

creased by about 10° F. Theoretically, equal comfort could be given at a much lower radiant intensity from the fire. In practice the background heating tends more to give a much wider comfort zone and also removes the need to preheat the

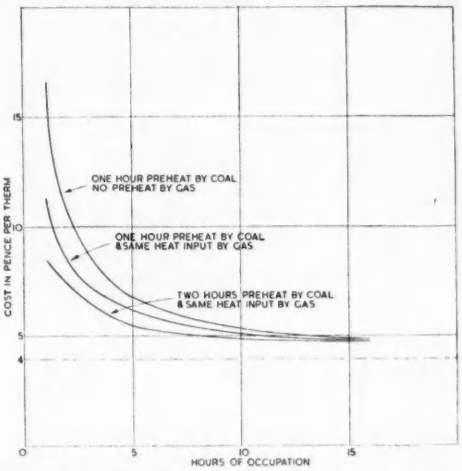


FIGURE 3.—*Comparison of Cost of Gas and Coal Fires*

room by the fire. Experience indicates that the rise in air temperature given by the background heater is greater than that given by the coal fire after preheating for 2 hours. A background heater in a 1,500 cu.ft. room would be rated at an output of 2,700 B.Th.U. per hr., giving the running cost shown in Table 10.

TABLE 10.—*Running Cost of Background Heater*

Use of Background Heater, Hr. per Day.	Daily Cost, Pence.	
	At 9d. per Therm.	At 4d. per Therm.
1	2	3
6	1·6	0·7
12	3·2	1·4
24	6·5	2·9

These figures are surprisingly low if compared with the costs already given for heating with a fire only. It must also be remembered that the cost of using the fire will be reduced as the room is already preheated by the background heater. It can be shown that with gas at 9d. per therm a background heater used for 6 hours per day costs about 1d. per day extra if a coal fire is used; at 4d. per therm there would be no extra cost.

Similarly, it costs almost ½d. a day extra to use a gas fire and a background heater for 6 hours, each at 9d. per therm; at 4d. per therm the background heater would show a slight saving compared with the gas fire only.

It must be emphasized again that greater comfort throughout the room is obtained when the background heater is used.

The coke fire has not been considered adequately in this Paper because there is little information to add to that given by Davidson and Hartley.[11] For the moment it can only be assumed that the cost of operation of a coke fire is about three-quarters of that of a coal fire.

Gas and Electricity

This comparison is also not straightforward. A comparison of the total heat output of a gas and an electric fire does not credit the gas fire with the greater degree of comfort given due to the ventilating effect and lower air temperature for comfort.

A comparison on the basis of equivalent radiant heat output does not credit the electric fire with the extra warmth comfort given by the convected heat.

A comparison of flueless gas heaters and electric heaters is reasonably satisfactory and applies to fires, radiators and convectors.

The gas appliance is also not credited with the completely flexible turn down of heat output by a tap compared with the larger steps in heat output of an electric heater.

The following table gives a cost comparison:

TABLE 11.—*Comparison of Gas and Electric Heaters*

—	Total Heat (Flued Fire).	Radiant Heat (Flued Fire).	Total Heat (Flueless Appliance).
	Equivalent Price of Gas per Therm, Pence.		
1	2	3	4
Electricity, per unit:			
¾d.	12¾	16½	18
½d.	8½	11	12
	Equivalent Price of Electricity per Unit, Pence.		
Gas, per therm:			
1s.	0·7	0·55	0·5
9d.	0·55	0·40	0·35
4d.	0·25	0·28	0·15

ESTIMATED ACTUAL RUNNING COST

The annual cost of providing different degrees of comfort must ultimately be obtained from a large number of examples of houses heated by different methods. Cost is so important, however, that an attempt will be made to estimate it for a particular set of circumstances. It is felt that the consumer, and to a lesser extent the Gas Industry, regard heating appliances as units costing so much per hour to run and do not consider the total cost of heating a house. For this reason even an approximate estimate is of value.

Consider a house with a living room and dining room of 1,500 to 2,000 cu.ft. capacity, a small hall, two flued bedrooms (each about 1,200 cu.ft.), one smaller flueless bedroom and a kitchen about 800 cu.ft. A 16 in. coal fire would be a satisfactory size for the living room and dining room.

Necessary Heating Requirements

Living Room.—Three different standards of comfort must be taken. For ideal conditions a fire is needed for 210 days each year and, in addition, a background heater for 140 days. The room is assumed to be occupied continuously for 8 hours each day and the background heater is alight for 12 hours each day. Comfort conditions are reasonable but not so good if there is no background heater or if expense is reduced by using the fire alone for 140 days and a flueless fire rated at 5,000 B.Th.U. per hr. for the other 70 days.

It is assumed that if a background heater is in use a preheat of one hour by the coal fire and no preheat by the gas fire is satisfactory; with no background heater a preheat equivalent to 2 hours by the coal fire is needed.

The following table gives the estimated cost:

TABLE 12.—*Estimated Cost of Heating Living Room*

System.	Annual Cost (Coal at 2s. 6d. per Cwt.).	
	Gas at 9d. per Therm.	Gas at 4d. per Therm.
1	2	3
	£ s. d.	£ s. d.
Coal fire plus background heater ..	8 0 0	7 0 0
Gas „ „ „ ..	11 10 0	5 0 0
Coal fire only	6 15 0	6 15 0
Gas „	11 5 0	5 0 0
Coal fire plus flueless gas fire ..	5 10 0	5 0 0
Gas „ „ „ ..	8 10 0	3 15 0

Dining Room.—Again, the three standards of comfort are taken and occupation is assumed to be for two periods—each of ¼ hr. If there is no background heater the preheat by the gas fire is equivalent to one hour by the coal fire.

TABLE 13.—*Estimated Cost of Heating Dining Room*

System.	Annual Cost (Coal at 2s. 6d. per Cwt.).	
	Gas at 9d. per Therm.	Gas at 4d. per Therm.
1	2	3
	£ s. d.	£ s. d.
Gas fire plus background heater ..	3 14 0	1 14 0
„ „ only	3 0 0	1 8 0
„ „ plus flueless gas fire ..	2 4 0	1 0 0

"IT LOOKS BETTER!"

Modern, streamlined appearance. Beautifully finished in glass-smooth, grey-mottled "Porceliron" enamel, or in black and white. Cooker can be supplied with a cover top fitted with a folding plate rack.

"IT COOKS BETTER!"

Fitted with Cannon "Autimo" Oven Heat Control—ensuring successful cooking. The "High-Speed" griller heats to redness in one minute, and is ideal for rapid and efficient grilling.

"IT'S EASIER TO CLEAN!"

Glass-smooth "Porceliron" surface requires but a wipe to restore its showroom lustre. There are no gates, and the embossed cast-iron enamelled sides are easy to clean.

For these reasons more housewives decide to

Instal a CANNON Gas COOKER

Cannon Iron Foundries, Ltd., Deepfields, Nr. Bilston, Staffs.

London: Thames House, Westminster, S.W.1.

Desirable Heating Requirements

Hall.—A flueless heater rated at 5,000 B.Th.U. per hr. is assumed to be adequate if used for an average of 12 hr. each day. Two standards of comfort are considered. Heating for 160 days a year or for 70 days.

TABLE 14.—*Estimated Cost of Heating Hall*

Usage, Days per Year.	Annual Cost.	
	Gas at 9d. per Therm.	Gas at 4d. per Therm.
1	2	3
	£ s. d.	£ s. d.
160	3 12 0	1 12 0
70	1 12 0	14 0

Kitchen.—A flueless fire of 5,000 B.Th.U. per hr. is in operation on an average for 6 hr. a day.

TABLE 15.—*Cost of Heating Kitchen*

Usage, Days per Year.	Annual Cost.	
	Gas at 9d. per Therm.	Gas at 4d. per Therm.
1	2	3
	£ s. d.	s. d.
160	1 16 0	16 0
70	16 0	7 0

Bedrooms.—On average a fire rated at 15,000 B.Th.U. per hr. is used for two periods of ½ hr. each day in two rooms for 160 days a year or 70 days, according to the degree of comfort required.

TABLE 16.—*Cost of Heating Bedrooms*

Usage, Days per Year.	Annual Cost.	
	Gas at 9d. per Therm.	Gas at 4d. per Therm.
1	2	3
	£ s. d.	s. d.
160	1 16 0	16 0
70	16 0	7 0

Summary of Data on Actual Running Cost

Taking as standard a house heated by a coal fire in the one room, the increase in cost is given of providing background heating, hall heating and bedroom heating with gas at 9d. per therm. The cost of an all-gas heating system at 4d. per therm is also given.

At 9d. per therm the lower comfort standard already discussed is taken and at 4d. per therm the higher comfort standard. Even at the lower standard there is a degree of central heating which will give much improved comfort not only in individual rooms but all over the house compared with the comfort given by the coal fire only.

A similar comparison is given for a house in which heating is by means of a coal fire in the living room and a gas fire at 9d. per therm in the dining room.

TABLE 17—*Comparison with Annual Cost of Coal Fire in the Living Room.*

Heating Provided.	Annual Cost. £ s. d.	Increase in Cost. £ s. d.
1	2	3
With Gas at 9d. per therm :		
Coal fire only (Coal at 2s. 6d. per cwt.)	**6 15 0**	Nil
,, ,, +background heater	8 0 0	1 5 0
,, ,, +hall heater	8 7 0	1 12 0
,, ,, +bedroom fires	7 11 0	16 0
,, ,, +flueless fire	5 10 0	−1 5 0
Coal fire +background heater+hall heater+bedroom fires	10 8 0	3 13 0
Coal fire+flueless fire+background heater +hall heater+bedroom fires	9 3 0	2 8 0
With Gas at 4d. per therm :		
Coal fire only	**6 15 0**	Nil
Gas fire only	5 0 0	−1 15 0
,, ,, +background heater	5 0 0	−1 15 0
,, ,, +hall heater	6 12 0	−1 3 0
,, ,, +bedroom fires	5 16 0	− 19 0
,, ,, +kitchen heater	5 16 0	− 19 0
Gas fire+background heater+hall heater +bedroom fires+kitchen heater ..	8 4 0	1 9 0

TABLE 18—*Comparison with Annual Cost of Coal Fire in Living Room and Gas Fire at 9d. per Therm in Dining Room*

Heating Provided.	Annual Cost. £ s. d.	Increase in Cost. £ s. d.
1	2	3
With Gas at 9d. per therm :		
Coal fire + gas fire	**9 15 0**	Nil
Coal fire+background heater+gas fire+ hall heater+bedroom fires	13 8 0	3 13 0
Coal fire+flueless fire+gas fire+flueless fire +hall heater+bedroom fires	11 3 0	1 8 0
With Gas at 4d. per therm :		
Gas fire+background heater+gas fire+ background heater+hall heater+bedroom fires+kitchen heater	9 18 0	3 0

Although the assumptions made are arbitrary and practical confirmation is necessary, the figures obtained do suggest that if the heating of the house is considered as a whole it is possible by gas heating to provide a very much improved degree of comfort at low expense. In particular, the economy, at 9d. per therm, of using a flueless fire for mild weather should be noted; also at 4d. per therm the economy of changing completely to gas for heating.

Combined Dining and Living Rooms

An alternative method of using the coal fire in the living room is to keep the fire alight for, say, 16 hr., during which period the fire is banked up to give its lowest output for, say, 6 hr. Comparative costs can be worked out on the assumption that a gas fire would be required to give comfort for 8 hr. continuous occupation plus two separate periods of occupation of 1 hr. and that the gas fire is used at half the normal rate for 6 hr.

As an alternative during the mild weather a flueless gas fire is used for 10 hr. and in cold weather the flueless fire provides the preheat for the flued fire and also heats the room during the 6 hr. when it is not definitely occupied.

TABLE 19.—*Comparison with Annual Cost of Coal Fire in Combined Dining and Living Room.*

Heating Provided.	Annual Cost.		Extra Annual Cost Above Coal Fire Only.	
	With Gas at 9d. per Therm.	With Gas at 4d. per Therm.	With Gas at 9d. per Therm.	With Gas at 4d. per Therm.
1	2	3	4	5
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Coal fire only	**8 13 0**	**8 13 0**	*Nil*	*Nil*
Gas fire only	—	7 5 0	—	−1 8 0
Coal fire + flueless fire..	7 14 0	6 2 0	−19 0	−2 11 0
Gas fire + flueless fire ..	—	5 19 0	—	−2 14 0

Under these different conditions the saving at 9d. per therm using a flueless fire is marked and also the economy at 4d. per therm of changing over to gas entirely.

PRACTICAL COMPARISON OF COAL, COKE AND GAS FIRES

A series of daily tests have been carried out from November, 1938, to March 1939, in three fairly similar rooms in a domestic house.

Each day of the test all the rooms were heated simultaneously either by a gas, coal or coke fire in order to eliminate variations in outside conditions. At the end of each day the fires were interchanged between the rooms in order to eliminate any specific effects due to difference in room location and construction.

Complete comfort was assumed at a globe thermometer temperature of 68° F. at the centre of the room and the room was regarded as heated up sufficiently for occupation when this temperature reached 60° F. These conditions were very comfortable to the observer who was present in the room over the whole period of test.

Loading of the solid fuel fires was carried out hourly in order to maintain as far as possible a steady temperature, and the gas fire was manually controlled. The gas fire was of the inset type with a bench radiant efficiency of 50 per cent. and a maximum gas rate of 35 cu.ft. per hr., the coal fire being a 15 in. Heaped fire and the coke fire a 15 in. Kaye. The coal fire was ignited by a gas poker and the coke fire by the igniting burner provided. The coal used was

Best Derby Brights at £2 14s. per ton and the coke was open fire coke at £2 5s. per ton.

Most of the tests covered an occupational period of 4 to 6 hr. but some were extended to 12 hr. in order to obtain the rate of fuel consumption under equilibrium conditions. Equilibrium was reached in about 7 hr. Unfortunately the weather was unusually mild and the results are only completely satisfactory for a range of outside temperature of 43° to 53° F.

From the figures obtained the time to heat up a room and the cost of maintaining comfort for different occupational periods can be found for different outside day air temperatures.

The following table gives the average figures obtained:

TABLE 20.—*Average Time to Obtain Comfort Using Different Fuels*

Outside Temperature, ° F.	Time to Heat Up, Hr.		
	Gas.	Coal.	Coke.
48 to 53 (42 tests)	0·2	0·68	0·41
38 to 43 (16 tests)	0·66	1·15	0·87

Figure 6 gives the cost of obtaining comfort for occupational periods up to 12 hr. at outside temperatures between

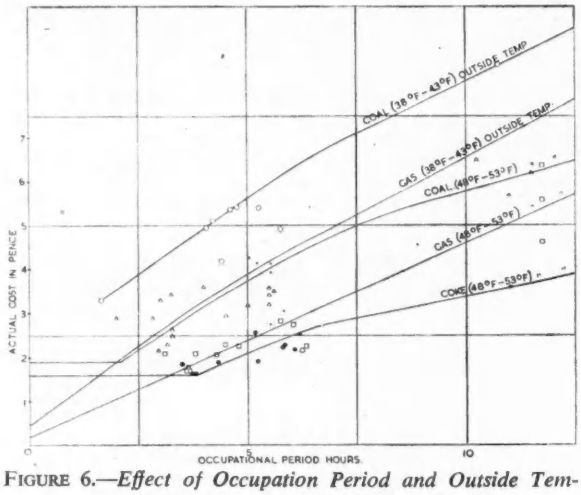


FIGURE 6.—*Effect of Occupation Period and Outside Temperature on Cost to Maintain Comfort.*

Coal: 2s. 6d. per Cwt.
Gas: 4d. per Therm.
Coke: 2s. 4d. per Cwt.

48° and 53° F. for gas, coal and coke and between 38° and 43° F. for gas and coal.

The actual costs given will be lower than those for a house in which only the living room is heated for any considerable period each day, as each of the test rooms was adjacent to another heated room.

It is reasonable, however, to draw the following conclusions:

(i) Gas at 4d. per therm will be cheaper than coal at £2 10s. a ton, even for very long periods of occupation.

(ii) Gas at 5d. per therm will be cheaper than coal at £2 10s. per ton for periods of occupation of 6 or 7 hr.

(iii) Gas at about 3d. per therm is necessary to compete on cost with coke at £2 5s. per ton for long occupational periods.

These results agree reasonably well with the theoretical calculations previously mentioned. It is felt that a much more careful control was kept over the coal fire than would normally happen in practice and it is expected that figures of practical usage would be even more favourable to gas.

CENTRAL HEATING

CALCULATION OF RUNNING COSTS

There is not sufficient room in this Paper to explain in full the method used for estimating running costs of central heating installations.

The load factors and heating seasons in Table 21 are based on the average daily temperatures taken over a number of years.

Methods of Calculation of Cost

The following examples are merely intended to show the methods of calculation:

Private House

Particulars: Central heating.

(i) Net heat loss including pipes = 45,000 B.Th.U. per hr.

(ii) Temperature required = 65° F. during the day, reduced for 8 hr. at night to 55° F.

The building is fully heated and the installation will be thermostatically controlled.

TABLE 21.—*Load Factors and other Data*

Type of Building.	Number of Hours at Various Load Factors.									Temp. °F.	Heating Season, Days per Year.	Remarks.
	0·15	0·20	0·25	0·45	0·47	0·50	0·52	0·75	1·0			
1	2	3	4	5	6	7	8	9	10	11	12	13
Private house Flats Hotels (normal)	—	—	8	—	16	—	—	—	—	65	240	If 60° F. is specified, a heating season of 210 days should be allowed. Mean load factor = 0·4.
Offices (1) ..	12	—	—	—	—	12	—	—	—	60	210	Alternatives suggesting different modes of use. The lower load factor should be taken at week-ends. Mean load factor = 0·33.
Shops (2) ..	—	12	—	—	12	—	—	—	—			
Schools (3) ..	—	—	—	—	—	—	—	—	—			
Factories	14	—	—	—	8	—	—	—	2			
Cinemas (1)	—	—	—	—	—	—	12	—	—	65	240	Alternatives. Allowance should be made for occupation.
(2)	—	—	—	—	10	—	—	—	2			
Clubs (1) Non residential ..	8	—	—	—	16	—	—	—	—	65	240	
(2) Residential ..	—	—	8	—	16	—	—	—	—	—	—	
Hospitals	—	—	—	—	24	—	—	—	—	65	240	
Hotels and Boarding Houses	—	—	8	—	16	—	—	—	—	65	240	
Churches and Concert Halls (1) ..	—	—	—	—	—	60/wk	—	—	—	60	210	Alternatives. Dependent upon total time of occupation.
	—	—	—	—	20/wk	—	—	20/wk	—			
Garages and Storage ..	—	—	24	—	—	—	—	—	—	45	120	

Note.—The natural heating season for 65° F. is 240 days, but in most cases installations are rarely used for more than 32 weeks.

Estimated Annual Gas Consumption

(i) Day period:
16 hours at a load factor of 0·47.

$$= \frac{45{,}000 \text{ (heat loss)} \times 16 \text{ (hours)} \times 240 \text{ (Heating season for 65° F. in days)} \times 0{\cdot}47 \text{ (load factor)}}{100{,}000 \text{ (therms)} \times \frac{77}{100} \text{ (boiler efficiency)}}$$

$$= \frac{45{,}000 \times 16 \times 240 \times 0{\cdot}47}{77{,}000} = 1{,}050 \text{ therms}$$

(ii) Night period.
8 hours at load factor of 0·25.

$$= \frac{45{,}000 \times 8 \times 240 \times 0{\cdot}25}{77{,}000} = 280 \text{ therms}$$

Total = 1,330 therms

Block of Offices

(i) Net heat loss including pipes ..	3,500,000 B.Th.U. per hr.
(ii) Temperature required	60° F. during the occupational period.
(iii) Office hours..	9 a.m. to 5 p.m., Mondays to Fridays. 9 a.m. to 1 p.m., Saturdays.

The building is fully heated and the installation will be thermostatically controlled. Clock control will be included to reduce the boilers to by-pass rate at night and at week-ends, the boilers being switched to full rate one hour before the building opens each day.

Estimated Annual Gas Consumption

Central heating:
(i) Day period.
12 hours per day (excluding week-ends) is taken at a load factor of 0·5. This allows for a suitable heating-up period.

Heating season .. .. .. 30 weeks
5½ days for 30 weeks .. .. 165 days

$$\text{Gas Consumption} = \frac{3{,}500{,}000 \times 12 \times 165 \times 0{\cdot}5}{77{,}000} = 45{,}000 \text{ therms}$$

(ii) Night period (12 hours):
By-pass rate is taken at 0·15 of the full load.

5½ nights for 30 weeks .. .. .. = 165, 12-hr. periods
1½ complete days (week-ends) for 30 weeks = 90, 12-hr. periods
Total .. .. .. = 255, 12-hr. periods

$$\text{Gas Consumption} = \frac{3{,}500{,}000 \times 12 \times 255 \times 0{\cdot}15}{77{,}000} = 21{,}000$$

Total = 66,000 therms.

The method of calculating running costs given for both domestic and non-domestic situations has been used for several years, but experiments have been made with the load factors and those given in Table 21 were first used last year. For this reason, there are no full results to offer, but observations of consumptions to date show that these estimates are closer than they have ever been in the past.

From experience, it seems that the householder who has a central heating installation uses it only as a form of background heating. It is rare to find a house centrally heated above 60° F. and in many cases the heating system is only used for about three months in the year.

The estimated heating costs shown in Table 22 are based on assumed continuous service for over thirty weeks.

Domestic Premises

Background heating directly by gas has already been dealt with but the question of using gas as the means of heat for the boiler of a central hot water heating system must be considered.

In this modern age, comfort is appreciated not only for its own sake but to the extent that people are prepared to pay more for it, provided that it is obtained with the minimum of trouble. For this reason, gas is the ideal fuel for this purpose and its advantages are too well known to need repetition in detail.

Automatic controls for gas-fired boilers have reached such a high standard of perfection that a boiler can literally be left entirely to its own devices, the essential features being a time switch of some sort to open up and shut down the heating at predetermined times, either a room thermostat or an outdoor compensating controller to regulate the internal temperature, and a safety device to shut off the main gas supply to the boiler in the event of breakdown of any sort.

In these days the householder is far more concerned with the comfort and happiness of his domestic staff than ever before. The domestic servant problem has probably never been more difficult, and for this reason gas has been the solution in very many instances.

Comparative costs between gas and coke are given in Table 22, but it must be appreciated that these are estimated costs. When gas is the fuel, the service given is so much better than that given by any other fuel that householders are definitely inclined to make greater use of it than if some form of solid fuel is used.

It is felt that, on the whole, the British public has accepted conditions, in homes and offices, which would not be tolerated in other countries. This phase is now passing rapidly, comfort is becoming more and more appreciated, and the Gas Industry has the means of giving this comfort in the most efficient manner possible.

Estimated Heating Costs for Central Heating by Radiators in Private Houses

(*Explanation of Table* 22)

Capital Cost

These figures are the same as those taken for offices, though it is probable that the actual costs would be higher.

Interest and Depreciation

As in the case of offices, *i.e.*, 15 years at 4½ per cent.

Table 22.—*Estimated Heating Costs for Central Heating by Radiators in Private Houses*

Size and Type of Installation	Capital Cost, £	Interest and Depreciation at 9·3 per cent., £	Fuel Consumption, Tons or Therms	Fuel Cost, £	Maintenance, £	Running Costs, Maintenance and Fuel Costs, £	Total Cost, i. e., including Depreciation, £	Notes
1	2	3	4	5	6	7	8	9
Boiler Power, 50,000 B.Th.U. per hr.								
Hand-fired coke	190	18	6·7	14·4	0·5	14·9	32·9	at 43s. 4d. per ton.
Automatic coke	220	20	4·9	11·0	1·0	12·0	32·0	at 45s. 0d. per ton.
Gas	175	16	1,185	19·75	0·65	20·4	36·4	at 4d. per therm.
Boiler Power, 100,000 B.Th.U. per hr.								
Hand-fired coke	230	21	13·3	28·8	0·5	29·3	50·3	at 43s. 4d. per ton.
Automatic coke	270	25	9·8	22·1	1·0	23·1	48·1	at 45s. 0d. per ton.
Gas	225	21	2,370	39·5	0·65	40·15	61·15	at 4d. per therm.
Boiler Power, 200,000 B.Th.U. per hr.								
Hand-fired coke	310	29	26·5	54·7	0·75	55·45	84·45	at 41s. 4d. per ton.
Automatic coke	370	34	19·6	40·5	1·5	42·0	76·0	at 41s. 4d. per ton.
Gas	325	30	4,740	79·0	1·25	80·25	110·25	at 4d. per therm.
Boiler Power, 300,000 B.Th.U. per hr.								
Hand-fired coke	400	37	39·8	82·2	0·75	82·95	119·95	at 41s. 4d. per ton.
Automatic coke	470	44	29·4	60·7	1·5	62·2	106·2	at 41s. 4d. per ton.
Gas	425	39	7,100	118·5	1·25	119·75	158·75	at 4d. per therm.
Boiler Power, 400,000 B.Th.U. per hr.								
Hand-fired coke	480	45	53·0	109·5	1·0	110·5	155·5	at 41s. 4d. per ton.
Automatic coke	570	53	39·2	81·0	2·0	83·0	136·0	at 41s. 4d. per ton.
Gas	525	49	9,480	158·0	1·55	159·55	208·55	at 4d. per therm.
Boiler Power, 500,000 B.Th.U. per hr.								
Hand-fired coke	560	52	66·5	137·5	1·0	138·5	190·5	at 41s. 4d. per ton.
Automatic coke	670	62	49·0	101·2	2·0	103·2	165·2	at 41s. 4d. per ton.
Gas	625	58	11,850	197·5	1·55	199·05	257·05	at 4d. per therm.

Fuel Consumption

Based on the maintenance of an internal temperature of 65° F. for 16 hr. per day, reduced during the night. The figures used are as follows:

Boiler Margin, per cent.		20
Heating Season, days		230
Load Factors, per cent:		
(i) Gas:	Day	47
	Night	25
(ii) Coke:	Day	48
	Night	25
Efficiencies, per cent:		
Hand-fired coke		50
Automatic coke		68
Gas		77

It is doubtful, particularly with regard to the smaller jobs, if an efficiency of 68 per cent. will be achieved in the case of the automatic coke jobs. The calorific values are:

Coke	12,500 B.Th.U. per lb.
Gas	500 B.Th.U. per cu. ft.

Fuel Costs

The cost of gas is based entirely on a rate of 4d. per therm. No standing charge has been allowed because it is not possible to judge what proportion of this will be absorbed by gas used for other purposes.

Coke costs are based on the Gas Light and Coke Company's contract rates for the particular tonnages.

Maintenance

In the case of gas, these costs comply with the Company's standard rates, allowance having been made for the number of visits advised by the Company. A nominal allowance has been made in the case of coke for the cleaning of flues, etc. No allowance has been made for labour for fuel and ash handling, though it is obvious that some value should be given to the added convenience resulting from the installation of a gas system.

[The Section on Heating of Non-Domestic Premises is omitted in our Abstract.]

THE FUTURE

Domestic

C. A. Masterman gives the average consumption of gas per domestic consumer as only 133 therms per annum and estimates that only 5 therms per annum are used on an average for room heating. Compared with such a figure the potential consumption of space heating appliances is startlingly high.

The following table gives estimated consumptions based on the earlier assumption on which cost figures were based:

Table 26.—*Estimated Annual Consumptions of Space Heating Appliances*

Appliance.	Approximate Potential Annual Consumption, Therms.
Gas fire in living room	200 to 300
Background heater in living room	50
Gas fire in dining room	80
Radiator in hall	40 to 90
Gas fire in bedroom	10 to 25
Flueless heater in kitchen	10 to 25
Auxiliary flueless fire in living room	30

During a recent technical survey covering about 300 domestic consumers representative of the area of the Gas Light and Coke Company, an attempt was made to discover some of the factors which prevent this potential load from being realized. The survey is not complete, and no real analysis of the results has been made, but the following impressions have been obtained:

(i) The present gas fire is sufficiently satisfactory for intermittent use in the dining room and bedroom, but is not sufficiently cosy, homely, or comfortable to replace the open solid fuel living room fire.

(ii) The total cost of heating a house for a year has rarely been considered.

(iii) Cold halls and cold rooms in the early stages of occupation are regarded as inevitable and costly to overcome.

(iv) The low annual cost of using gas fires in bedrooms regularly and for short periods is not appreciated.

(v) The use of a flueless gas fire in mild weather in dining and living room, and in the kitchen, is not understood as the most convenient and inexpensive method of obtaining reasonable comfort. This usage is handicapped often by the lack of suitable gas points in the various rooms.

(vi) If the family income is small, the cost of hire-purchasing the appliances absorbs a large proportion of the money available to spend on comfort.

(vii) The two-part tariff is thought of more to give a saving on the present gas bill rather than to make possible the extended usage of gas to give greater comfort.

It seemed that the problem of providing comfort had not been considered logically by the consumer, if at all, and there was confusion concerning the relative costs of different fuels both with regard to the units in which they were bought and the cost of providing any degree of comfort. The capital and installation cost of the appliance and the possible mess if no gas point is available are all against any introduction of a new appliance.

It is not possible to consider all these points, but an attempt is made herein to give some indication of possible developments of new appliances to aid the expansion of the space heating load.

Development of Individual Appliances

The Gas Fire

The present gas fire has a high radiant efficiency. It is not anticipated that there will be any marked increase in this efficiency and there are many circumstances where the fire is eminently suitable.

It is felt, however, that people who are accustomed to the open coal fire will not find the present gas fire sufficiently attractive to sit round. There is at the moment a feeling against the appearance and the comfort obtained from a gas fire as compared with a coal fire, but it is not yet known to what extent this is prejudice and to what extent it is based on physical differences.

It is possible, however, to obtain in a gas fire a close reproduction of the ventilation, distribution of radiation, emission spectra, distribution of light and dark patches, and even the flame of a coal fire. If such a fire is produced with a modern efficiency it will be able to compete with coal on a basis of running cost, cleanliness, work elimination, smoke abatement, etc., and it will replace the open coal fire in the living room of a large number of consumers who are on the two-part tariff or have a consumption even approaching their critical consumption.

Apart from reproducing the physical characteristics of the coal fire the gas fire must be:

(*a*) Cheap to buy. Any change from an existing grate will be particularly handicapped by any large initial cost. The potential load of a living room fire is so large that Gas Companies might well consider in a new light the lowest possible price at which the fire could be sold to the customer.

(*b*) Cheap to maintain. The consumer is accustomed to a coal grate which as a rule needs no maintenance and does not expect to pay for service. Also the appliance must not look in any way dilapidated after a period of use.

(*c*) Flexible to fit. The fire must be fitted neatly by the normal gas fitter into nearly all the different types of existing coal fireplaces.

(*d*) The radiant efficiency must be of the same order as the present modern gas fire.

(*e*) The flexibility of heat output, consistent with good efficiency and good appearance, must compare favourably with a coal fire, *i.e.*, a range of output of 3 to 1.

(*f*) The gas fire should preferably be capable of incinerating small articles such as cigarette ends, matches, etc.

(*g*) It is desirable to have some flickering free-burning flame, even if this is under separate control.

In order to fulfil these demands a gas fire must be designed on such new principles that it will never be to the user just a "gas fire", and it might be as well to coin a new phrase to define such a heating unit. Preliminary work has shown that it is not impossible to design a gas fire which fulfils the required conditions.

It seems logical that such a fire should be of the inset type and, in effect, be a unit which replaces the coal of the coal fire. It will then have a distribution of heat and a ventilating effect similar to a coal fire.

The radiant in its present form must be eliminated, as it is too weak mechanically and thermally for the heavy duty of a living room fire. In order to obtain robustness and efficiency it is possible either to make the front of the firebrick do duty as the back of the radiant or make the firebrick of such a section that it is the complete radiant. The radiant back unit must be flexible, probably by cutting, so that it can be fitted approximately to each particular fireplace.

Another possible development of gas fires, particularly for use in dining rooms and halls, is the convector gas fire and there are many circumstances where an increase in overall efficiency by means of additional convection heating would be a real advantage. A fire of high radiant efficiency with marked convection efficiency would show considerable advantage in time to obtain comfort and in running cost. Such a fire would be an alternative to the more flexible combination of fire and background heating.

Fires have been produced in which a heat interchanger immediately above the radiants scrubs out a proportion of the heat in the flue gases and increases of over 20 per cent. in overall thermal efficiency are practicable. One practical difficulty which has not yet been overcome is to obtain a sufficiently attractive appearance of the combined unit, as the heat interchanger tends to make a self-contained unit too deep and rather heavy in appearance.

Flueless Gas Fire

The reflector type of fire, both gas and electric, is very popular and is likely to continue, but it is doubtful if the development has been based on the real requirements of such a heater. The one type gives a wide distribution of radiant heat at low intensity but an appearance of brightness from any angle, and the other type gives a narrow distribution of radiant heat at high intensity but from only one viewpoint does the heater look bright.

It is possible that heaters should be designed to give a beam of heat of suitable compass to warm one, two or three people adequately by radiation and at the same time look bright from any angle. Such heaters could be produced by the use of a suitably shaped reflector so that either the individual corrugations were part of a parabolic reflector or a parabolic reflector was corrugated at fairly wide intervals. Of equal importance is an increase in robustness of the component parts so that maintenance would not be needed.

Although it may be retrograde, it is worth while to consider the introduction of a heater so robust and so easy to renovate that it could be placed on simple hire instead of hire purchase.

Control and Flexibility

It is felt that insufficient advantage is taken of the intrinsic advantage of gas as a fuel compared with any other fuel.

As far as manual control is concerned it is normally difficult, in space heaters, to turn down an appliance to a desired degree of heat without considerable trial and error. An example of particular importance is the gas fire, the tap of which frequently operates effectively only over a small range of its total travel. The tap is often in a warm place, any operations are carried out hastily, and it is difficult to see the flames because of the glow of the radiant. It is necessary to wait until the radiants have cooled down or heated up before it is known whether or not the control attempted has been successful. A proportional cock, preferably fitted some distance from the fire and possibly with some form of indicator to show the particular gas rate obtained, would be a marked advance.

An assured maximum gas rate is also important and it is logical to develop appliances with an integral governor if the optimum service is to be obtained.

It seems certain that the technical improvements desirable in space heating appliances will be achieved.

It is even more important to realize that with gas on the two-part tariff it is possible to achieve greater comfort, with great reduction in labour and inconvenience, by changing the living room fire from coal to gas. This increase in comfort is obtained at a very small increase in annual cost or even a decrease in annual cost. If gas is not obtainable on a tariff it is still possible to increase comfort at a very low cost by the use of background heating in the hall and living rooms; also, by the intelligent use of a flueless fire the annual fuel bill of any house can be reduced.

NON-DOMESTIC

Although blocks of flats and hotels have not been specially dealt with in this Paper, it seems reasonable to suppose that developments of gas for central heating will be appreciable in premises of this kind. Office buildings appear to offer even a larger field for development and for the application of gas for central heating. Individual heaters are, in general, unpopular with owners of these buildings, and they have little choice other than to install some system of central heating. Not only do regulations exist regarding the minimum amount of heating, but office staffs demand a better standard than existed in the past. From the point of view of the owner, gas has many definite advantages over other fuels in these situations. His building costs are reduced, he will have more letting space due to the compactness of the gas boiler plant, and he will not require to employ additional labour for its upkeep. Gas boiler plants can be designed so that the working is entirely automatic and in view of the intermittent demand for heating in offices (the buildings being occupied during the day and empty at night) the gas boiler lends itself admirably to such control. Full advantage can be taken of the economies which in general can be effected by lowering the temperature at night. The owner will also be assured of unfailing service.

It is expected that more centrally-heated low-temperature panel systems will be employed in the future, as comfort conditions are more easily obtained where a higher proportion of radiant heating is present as opposed to the high proportion of convection heating given by ordinary radiator systems. The existence of this low-temperature radiant surface also enables a greater degree of ventilation to be used without the discomfort which might otherwise result if the radiant surface were not present. It is generally experienced that low-temperature radiant panel systems provide minimum comfort conditions at a lower running cost than with heating systems depending chiefly on convected heat.

The unit heater, as adapted to domestic purposes, will become popular where capital cost is comparatively unimportant. Some of these heaters are designed to draw air from the outside, which air is blown through a humidifying device and then into the room. In winter, therefore, it is possible to employ this type for humidifying and heating, and in summer it can be used as a ventilating unit. It can either be heated from a central system or preferably by direct application of gas.

Buildings such as churches, halls, etc., which are used intermittently, are obvious positions for radiant panels. The capital cost and running cost of a hot water or steam plant would be higher. Owing to the speed in heating up, radiant panels require a shorter heating period; this fact, combined with the ease of control of the direction of the heat, gives them advantages with which no other form of heating can compete. A further advantage of radiant panels lies in the fact that those which are directed towards an unoccupied part of the building can be turned off without detriment to the comfort of the occupants in the remaining portion. Where convection heating is used, this would be impossible.

In industrial premises it would seem that, in the future, gas will be used more directly than heretofore, the heating appliances being direct-fired unit heaters and radiant heaters. The Gas Industry is now well equipped to deal with any heating installation, but the selection of the right apparatus to use in each case needs careful consideration.

Factory premises all produce different conditions. For example, it will be found that where a lot of heavy machinery is used, or goods are stored, the amount of heat absorbed by them at the beginning of the heating season is large. This may be an advantage, however, as it will be found sometimes that the amount of heat given off from these sources goes a long way towards reducing fuel consumption during the night if the plant is set to a maintenance temperature.

A factory or warehouse where a good deal of movement by the workers goes on will require less radiant heat than one in which the work is chiefly sedentary. At Heston Stores,

for example, the majority of the work consists of loading, unloading and packing gas apparatus. These workers are almost always on the move and their wants are satisfied by thermostatically-controlled unit heaters, placed in selected positions.

There are, however, a number of storekeepers whose work is chiefly sedentary. It has been found that unit heaters alone are insufficient for their needs; further, if they happen to be in a direct line with the air stream, they may find it unpleasant for any length of time. For this reason some low-temperature radiant panels are being fitted so that a greater sense of comfort will be obtained by these men. In many other cases where the premises are exposed and have appreciably high roofs, the application of radiant heaters for producing zones of comfort around sedentary workers will become more and more popular.

In comparison with other heating systems, that is, by radiators, pipes or even unit heaters operated from a central source, the consumptions are appreciably less. This is indicated by the estimated figures given in the Paper, which figures are confirmed by results obtained from factories employing this type of heating. Although information of this kind is somewhat limited at the moment, the results that have been obtained are sufficiently convincing to make a closer investigation desirable. Both unit heaters and radiant panels are cheaper and easier to install in comparison with other systems. The direction of the heat can be simply adjusted and the ease with which these appliances can be controlled results in maximum efficiency of heat distribution and minimum running costs. It can be foreseen that a combination of radiant heaters with an air heating system such as unit heaters will provide the solution for many factory heating problems in the future.

With direct gas-fired unit heaters, the heating mains are completely eliminated, and for intermittent heating the heating up of the bulk of the water contents of the plant is also eliminated. Therefore, gas unit heaters will reach their full output much more quickly than a central system, and individual and close control is achieved more easily. With directional gas panels and gas radiators, running costs would in general be cheaper than with central systems employing gas. In fact, figures obtained from actual plants show that in certain cases gas radiant panels have competed more than successfully with other fuels, even solid fuels. This may be due to the possibility of zoning, and the quicker comfort effect achieved by high-temperature radiation. Exact details of temperature produced are not available from the plants where these consumptions have been measured, however, but complete satisfaction has been expressed by the people working in the factories and by the owners.

Cinemas and theatres will inevitably be heated by a plenum plant, with or without complete conditioning. The gas-fired boiler will provide the necessary heat, but further investigation is required to ascertain whether a direct gas-fired heater battery would be entirely satisfactory.

It is hoped that actual consumptions and results with closer records will be obtained in the future, and at this moment steps are being taken to obtain more detailed statistics of various types of plants, which results may well form the basis for a further technical Paper and discussion.

Installation of Tower Gas Purifiers

Communication No. 212

by

CYRIL M. CROFT, M.Inst.C.E., M.I.Mech.E., M.Inst.Gas E.

(Chief Engineer and General Manager, Wandsworth and District Gas Company).

INTRODUCTION

The type of purifiers dealt with in this Paper is known as the Thyssen-Lenze Tower Purifier. The installation was constructed, with the exception of the gantry and crane, by W. C. Holmes and Company, Limited, under sole licence of Bamag-Meguin A.G. of Berlin, for Thyssen'sche Gas- u. Wasserwerke G.m.b.H. (British Patent No. 345,880).

The installation, which has a nominal capacity of 10 mill. cu ft. of gas per day, consists of six towers, comprising the actual plant, together with a stocking tower and stocking frame. The plant is constructed on foundations consisting of a reinforced concrete raft, the design of which is integral with the overhead gantry carrying the crane. The work in connexion with the foundations and the reinforced concrete gantry was carried out by A. E. Frost of Southgate. The work in connexion with the "live" gas mains from existing plant to the site of the new installation was carried out by William Press and Son of Edmonton.

The overhead handling crane, which is electrically operated, was manufactured by Babcock and Wilcox, Limited.

The objects of the present Paper are to deal with the reasons leading up to the adoption of tower purifiers by the Wandsworth and District Gas Company and to describe the construction of the plant, working results and financial aspects as ascertained up to the present. It is not intended, therefore, to deal in any way with the chemical aspects of purification of gas by ferric-oxide, as it is considered that whatever type of container is installed involving the use of ferric-oxide the chemical reactions are unchanged and well understood.

CENTRALIZATION OF MANUFACTURE

During the last ten years the Wandsworth and District Gas Company has absorbed, by amalgamation, several neighbouring Gas Undertakings. With the object of effecting economies it has been found expedient to close down some of the Works thus acquired and to reduce the manufacture of gas at others, centralizing the manufacture, as far as possible, at the main Works of the Company at Wandsworth, situated on the banks of the River Thames and where coals are delivered direct by sea-going colliers.

The manufacture of increased quantities of gas at Wandsworth and the reduction of the outputs at the other Works were rendered possible owing to the fact that the Company has recently completed a re-distribution station at Worcester Park. This station is located practically in the centre of the Company's area of supply, and gas from Wandsworth and other Works can be delivered there either under high or low pressures and from thence re-distributed to the district at predetermined pressures according to the requirements of the various areas of supply. Without this re-distribution station the centralization of manufacture at Wandsworth would not have been a possible proposition.

As already mentioned, the coal used at Wandsworth arrives in sea-going colliers, which navigate alongside a reinforced concrete pier or jetty, fitted with two hydraulic cranes and large receiving hoppers. This plant is capable of discharging colliers of 2,500 tons in approximately five hours. From the jetty the coal is carried by means of conveyors into the main coal stores adjacent to the retort houses and the service hoppers for loading into road wagons. The Wandsworth Works are therefore conducted with the minimum costs for handling coal and gas is manufactured there at the most economical rates. Coal for the other stations, however, has to be transported in road wagons, which entails added expense and consequently higher manufacturing costs. The amount of coal carbonized by the outlying stations is therefore determined by the quantity of coke required in these districts and the alternative cost of delivering it from Wandsworth.

The land scheduled for gas manufacture at Wandsworth is only some 28 acres in extent and as this station is growing

rapidly in magnitude the greatest possible care has to be exercised to ensure the best use being made of the undeveloped land.

The policy of the Company in centralizing the manufacture at Wandsworth has, from time to time, necessitated the provision of additional plant and a further installation of intermittent vertical ovens, having a capacity of 4 mill. cu.ft. per day, has been completed recently.

CONSIDERATIONS AFFECTING SELECTION OF PURIFYING PLANT

The additional carbonizing plant has, in turn, made it necessary to increase the dry purifying capacity of the Works, and it was decided to install purifying plant not only to meet the present demands, but also the normal and anticipated future demands that might be expected from the Wandsworth Works.

The decision to provide a further installation of purifiers having been made, the closest consideration had to be given to the type and the site for them.

The simplest arrangement for purifying plant and one which immediately presented itself was that type most commonly in use in England, namely, rectangular cast iron boxes on the ground level with a crane or other similar apparatus for discharging. Any departure from this system had to provide justification in the form of one or more of the following points:

(i) Reduction in the area of land occupied by the plant.
(ii) Lower cost in construction and maintenance.
(iii) Reduction in the handling costs and the time required for changing the material for the boxes

As regards purification itself, it is improbable that any alternative design could claim an actual improvement in efficiency of purification, as it would appear that most of the feasible grid arrangements must by this time have been explored very thoroughly.

This juncture having been reached the following alternatives presented themselves for consideration:

(*a*) The provision of a reinforced concrete building having three floors above ground level, arranged thus:

Ground floor — Revivifying space.
First floor — Rectangular boxes.
Second floor — Revivifying space.
Third-floor — Rectangular boxes.

or

(*b*) Deep boxes constructed either in cast iron or reinforced concrete,
or
(*c*) Tower purifiers.

Careful investigation from all angles eliminated the construction of a reinforced concrete storey building on account of the capital cost. It might be of interest to mention that the cost of a reinforced concrete building and purifiers, as described above, having a capacity of 10 mill. cu.ft. per day, was £75,000 as against £58,000 for the complete installation of tower purifiers, including the reinforced concrete gantry and crane. Further, the ground space required was approximately half.

Deep boxes were also eliminated owing to the fact that in operation the handling of the material was apparently expensive and the boxes in changing were out of commission for a considerable period.

Thus the conclusion was reached that tower purifiers most nearly fulfilled all conditions.

A very definite advantage presenting itself with this type was the economy in land space. The installation at Wandsworth occupies an area of some 12,000 sq.ft., included in which is space for the addition of two further towers to meet possible future requirements.

Plant of a similar capacity built in accordance with scheme (*a*) would occupy 20,000 sq.ft., and the remaining alternative of rectangular boxes built on ground level would have required 40,000 sq.ft. of land.

Further, it should be stated here that in order to increase the capacity of the present installation by one third it would only be necessary to add one extra bay as far as concrete work is concerned, the existing crane being capable of meeting such an extension.

It is, however, in the full development of the handling plant that the tower construction is worthy of regard. In a sense this handling plant is forced on the designer, because the form of the tower makes any handling by direct access to the interior a matter of difficulty. Power-operated handling having been provided for, however, the designer has it in his hands to accelerate the changing of the box contents while using a mere skeleton force of men. The duties of these men do not begin and end with a changing operation, as in the case of an ordinary labour gang, but include the preparation of the mass and containing trays before the operation, and the clearing out of the spent oxide from those withdrawn. Between these jobs there is the cleaning of the trays and making ready for the refilling.

Such complete mechanization would be relatively difficult with shallow boxes of large area, and even with good oxide handling plant an immediate increase in labour strength at the time of changing is demanded.

DESCRIPTION OF PLANT AND RESULTS OBTAINED

The Wandsworth installation, as has been stated, is designed to have a capacity of 10 mill. cu.ft. daily. Each tower consists of an outer shell 22 ft. 3¼ in. in diameter by 52 ft. 1 in. in height, closed at the top and bottom. The top cover is removable. Perpendicular guides and an access ladder are fixed on the inner wall.

Each tower contains 12 superimposed containers filled with oxide. These containers are polygonal, and each holds 2 layers of oxide supported on wooden grids. The oxide does not come into contact with the tower itself. Each container consists of a central tube and two oxide-containing trays. The central tube and outer walls are united by the bearers for the grids which extend radially from the centre tube. The wall of the container is provided with feet for resting on the container below, and also with rests for the container above. Each container is provided with lifting eyes. For the purpose of rapid handling, an extra set of containers is provided.

When the containers are placed one above the other in the tower the central tubes form a common gas inlet to the containers, the joint between successive containers being made by a rubber joint fixed in an annular recess.

The containers rest on a division plate some 3 ft. from the bottom, having a central opening coinciding with the central tubes of the containers. The main inlet to the tower feeds the gas space so formed between the division plate and the bottom, entering through the side plates. It might be noted that cast iron radiators are situated in this gas space for controlling the temperature of the inlet gas. Gas from the central tube enters through slots into the space between the two layers of oxide in each container, divides and passes through the layers of oxide, and escapes to the annular space between the walls of the containers and the shell of the tower. The outlet main is taken from half-way up the side of the tower.

The whole installation is built on a foundation consisting of a reinforced concrete raft supported by 144 piles, 14 in. × 14 in. The reinforced gantry on which the overhead handling crane travels was designed as an integral part of the foundation work and consists of 14 in. × 14 in. vertical columns at 28 ft. 6 in. pitch with the raker legs inclined towards the centre of the foundation in order to conserve the space surrounding the site chosen. The length of the gantry is 173 ft. and it is 72 ft. 3½in. in height with a span to accommodate the crane of 63 ft.

The crane is an electrically-operated travelling and cross traversing type, with a longitudinal travel speed of 100 ft. per min., and cross traversing speed of 25 ft. per min. It is provided with a main and auxiliary hoist, the former being of 50 tons and the latter of 8 tons, with lifting speeds of 12 and 40 ft. per min. respectively. The auxiliary hoist is provided

for the handling of any light material required for maintenance, refilling, etc.

For the purpose of handling containers, a special automatic lifting frame is provided with four hooks which engage with four corresponding eyes in each container, and is so designed that the crane operator can both hook on and release the containers without assistance, so that a man is not required in the tower.

Gas Connexions and Water Seal Valves

Figure 1 shows the six towers connected in series and numbered 1 to 6. Each tower has 7 water seal valves, an

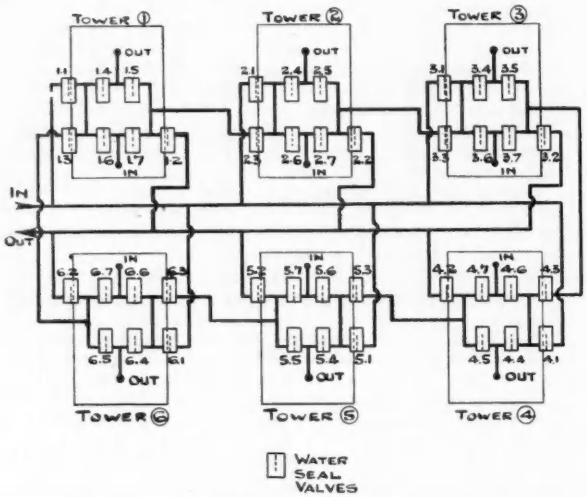


FIGURE 1.—*Diagrammatic Arrangement of Gas Connexions to Tower Purifiers.*

inlet, an outlet, a connexion inlet valve, and 4 reversing valves. Each valve has its special identification number; this number consists of two figures, the first figure referring to the tower to which the valve belongs, and the second figure referring to the purpose the valve serves. For example, the valve numbered 1.1 refers to the inlet valve on tower 1, valve 1.2 refers to the outlet valve on tower 1, valve 1.3 refers to the connexion inlet valve on tower 1. The reversing valves on tower 1 are numbered 1.4, 1.5, 1.6, 1.7; for upward flow of gas, valves 1.5 and 1.6 are open, and valves 1.4 and 1.7 are shut and vice-versa for downward flow of gas. The water seal

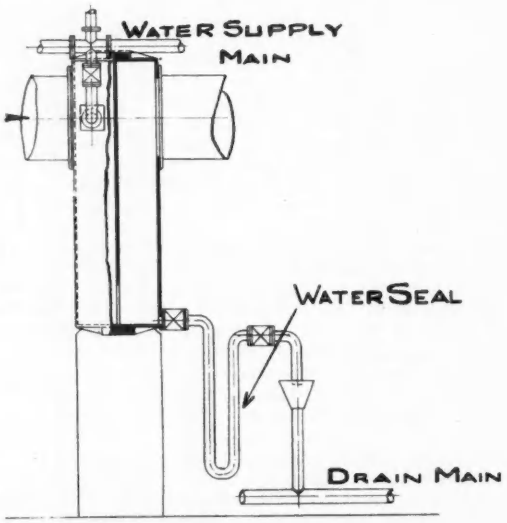


FIGURE 2.—*Section of Water Seal Valve.*

valves are connected with gas connexions 30 in. in diameter. The valves are arranged for operation from a central operating platform running between the towers at a convenient height from the ground.

Figure 2 shows a section through a water seal valve illustrating sealing arrangement and water supply lines.

General Working and Rotation

For normal working of the towers the backward rotation system is used; for the first 6 towers there are accordingly 6 different positions for each tower.

TABLE 1.—*Backward Rotation System*

1st Receiver.	2nd Receiver.	3rd Receiver.	4th Receiver.	5th Receiver.	6th Receiver.
1	2	3	4	5	6
6	1	2	3	4	5
5	6	1	2	3	4

and so on.

Referring to Figure 1, it can be seen that for the order 1, 2, 3, 4, 5, 6 with an upward flow of gas in each tower, the inlet valve to tower 1, *i.e.*, valve numbered 1·1, is open, the remaining inlet valves 2.1, 3.1, 4.1, 5.1, 6.1 all being shut. The outlet valve on tower 6 is open, *i.e.*, valve numbered 6.2, the remaining outlet valves 1.2, 2.2, 3.2, 4.2, 5.2 being shut; the reversing valves 1.5, 1.6, 2.5, 2.6, 3.5, 3.6, 4.5, 4.6, 5.5, 5.6, 6.5, 6.6 are open and the reversing valves 1.4, 1.7, 2.4, 2.7, 3.4, 3.7, 4.4, 4.7, 5.4, 5.7, 6.4, 6.7 are shut; all the connexion inlet valves are open with the exception of the connexion inlet valve on tower 1, *i.e.*, valve numbered 1.3.

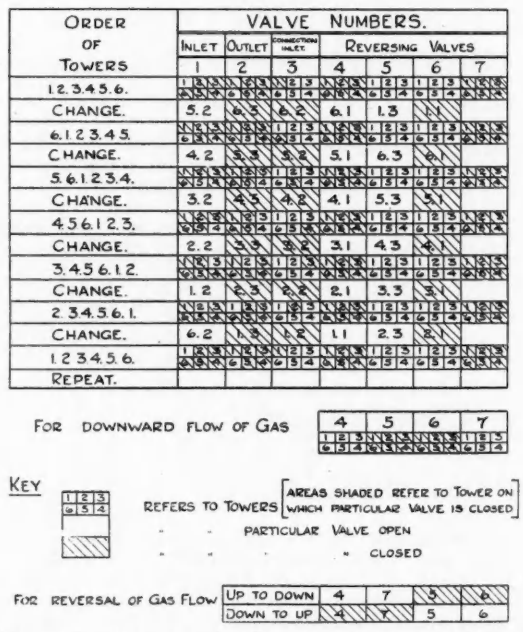


FIGURE 3.—*Procedure for Changing Rotation of Towers*

To change the order of the towers from 1, 2, 3, 4, 5, 6, to 6, 1, 2, 3, 4, 5, necessitates operating 6 valves and is accomplished in the following order:

1. Open valve 5.2, the outlet valve on tower 5.
2. Shut 6.3, the connexion inlet valve on tower 6, the new first receiver.
3. Shut 6.2, the outlet valve on tower 6.
4. Open 6.1, the inlet valve on tower 6.
5. Open 1.3, the connexion inlet valve on tower 1.
6. Shut 1.1, the inlet valve on tower 1.

Figure 3 is a table indicating the procedure adopted when changing the rotation of the towers (upward flow of gas).

Flexibility

The purifiers have proved to be flexible in that they have worked equally well from half capacity to 33 per cent. overload. In addition, it should be noted that the two towers discharged to date have shown 44 per cent. of pure sulphur in the spent oxide and it is anticipated that the percentage of sulphur will be increased in future as the series is worked into better gradation of sulphur content in individual towers.

In view of the above percentage of sulphur in the spent oxide allowing for the sale of the material without the necessity of discharging, breaking and preparing for a further fouling in the towers, there is a consequent saving in the cost of handling, breaking and preparing oxide, with a resultant saving in the cost of purification.

Working of Plant

The plant has now been in operation for twelve months, *i.e.*, from 8th June, 1938, tower 1 being discharged on 8th December, 1938, and tower 2 on 16th February, 1939.

The purifying material used throughout consists of a mixture of 70 per cent. Dutch bog ore with 30 per cent. Lux. In the cases of towers 1, 2 and 3 a special procedure was adopted in order to obtain a gradation of the sulphur content. A quantity of the above bog ore/Lux mixture was previously fouled in the box purifiers and this was mixed with fresh oxide mixture so that towers 1, 2 and 3 were filled with oxide containing differing percentages of sulphur in the wet material as shown in the following table:

Table 2.—*Composition of Oxide*

Tower No.	Water, Per Cent.	Sulphur, Per Cent.	Weight, Tons.
1	2	3	4
1	22·0	24·3	348
2	31·5	15·2	334
3	32·0	12·5	320
4	45·6	*Nil*	295
5	42·3	*Nil*	295
6	46·7	*Nil*	295

The total volume of oxide is equal to 6·6 cu.ft. per 1,000 cu.ft. of gas per day.

To put the towers to work the water-sealed valves on the towers were arranged so that a stream of gas passed through the towers and connexions in the order 4, 5, 6, 1, 2, 3. The main outlet of tower 3 during this operation was closed and the vent valve on the cover of tower 3 was wide open. Tests were taken of the gas leaving tower 3 vent valve, and when the oxygen showed that the blowing off of the air was completed the main outlet of tower 3 was opened and the vent valve closed.

It was previously ascertained by laboratory testing that the material in towers 1, 2 and 3 did not give a stain of H_2S (bog stain) on passing clean gas through it, whereas the material in towers 4, 5 and 6 gave a slight bog stain. Accordingly, it was decided to foul towers 4, 5 and 6 each to the extent of a few tons of sulphur and then to revivify them with towers 1, 2 and 3 at the end of the series to remove any bog stains during this process.

The gas throughput for the first 14 days was approximately 5 mill. cu.ft. per day.

The procedure adopted for removal of bog stains was to pass the gas through towers 4, 5, 6, 1, 2, 3 for five days, then 5, 6, 1, 2, 3 for two days with tower 4 shut off, then 6, 1, 2, 3 for two days with towers 4 and 5 shut off. After this the towers were ready to put to work in the ordinary system of backward rotation, commencing with the order 4, 5, 6, 1, 2, 3.

In order to obtain the best sulphur content of the mass, tower 1, containing the highest percentage of sulphur, is kept in the first position as long as possible, subject to the efficiency of H_2S removal not falling unduly.

It was ascertained that the best length of time for tower 1 to be in the first position was that in which 7 to 10 tons of sulphur were absorbed in it. The backward rotation is then operated with each of the other towers for approximately one day only in the first position.

When No. 1 again arrives in the first position the direction of flow of gas through it is reversed. All the oxygen for revivification *in situ* is admitted with the inlet gas to such an extent that from 0·4 to 0·5 per cent. is present in the gas leaving the purifiers.

It must be noted that when tower 1 falls in efficiency so that it is unable to absorb 7 to 10 tons of sulphur before a faint stain appears at the outlet of tower 5, rotation as described must be commenced earlier, and when advisable the other towers can be on the first position for less than one day in order to maintain the proper gradation of sulphur in the series of towers. At no time should the temperature of the inlet gas be allowed to fall below 68° F., and the temperature in any towers should not be allowed to rise above 110° F.

SUPERVISION DURING OPERATION

Tests

Every day the following tests must be made:

(*a*) Temperature of inlet and outlet of every tower.

(*b*) Outlet pressure, every tower.

(*c*) Back pressure on whole plant.

(*d*) Lead paper tests on the last four towers.

(*e*) Cadmium acetate test on the crude gas inlet and at the outlet of each tower passing measurable quantity of H_2S.

(*f*) Oxygen test at the inlet and outlet of the first tower and at the main outlet.

(*g*) Ammonia test of crude gas inlet.

From the above supervision tests a log is kept of the weight of sulphur absorbed by each tower and when the first tower contains sufficient sulphur to render the mass of saleable quality the tower can be discharged.

A convenient quantity of ammonia to be admitted with the inlet gas is found to be approximately 2 gr. per 100 cu.ft.

Oxide Management

Enrichment of Oxide

With a tower containing 300 tons of fresh oxide and a gas rate of 10 mill. cu.ft. per day containing 500 gr. of H_2S per 100 cu.ft. of gas, the oxide is capable of absorbing 165 tons of sulphur in 55 days to give an enrichment of 45 per cent. sulphur, when the oxide must be changed.

Filling the Containers with Fresh Oxide

Since the oxide filling of the containers is the most important part of the process this must be carried out with great care.

In the mixing of Lux and bog ore with each new filling the mass must be freed from lumps and mixed three or four times. The mixture must be lightly filled into the containers, and on no account must it be beaten down in any way. Rakes must be used and not shovels for spreading. During the filling of the containers the rubber jointing ring must be laid in its groove. The containers must be filled not later than one month before being required for use.

Changing a Tower

When the oxide in any tower is enriched with sulphur to saleable quality, the tower must remain three to four days in the last position to complete revivication of the oxide, the flow of gas through the tower being reversed in direction daily.

The tower is then isolated from the gas stream and inert gas, generated by means of a Harrison purging machine, is fed into the bottom of the tower through the purging gas

main connexion and discharged through the vent valve on the top cover until tests indicate that no coal gas remains in the tower. The Harrison purging machine consumes 3,000 cu.ft. of coal gas per hr. and produces approximately 15,000 cu.ft. of inert gas per hr.

During the process of purging, frequent tests are made of the inert gas to ensure that complete combustion without an excess of oxygen is maintained throughout.

When the purging is completed the cover is removed and the oxide containers transferred to the stocking tower. The fresh oxide containers are then taken from the stocking frame and placed in the tower. The tower covers are then replaced and it is then ready for blowing off and putting to work. The times taken for the various operations were as follows:

Purging tower	1½ hr.
Discharging tower	2 hr.
Sweeping out base of tower and renewing bottom sealing ring	¼ hr.
Filling tower, replacing inlet sealing cap, and tower cover	2½ hr.
Total time	6¼ hr.

Results Obtained

The results given in Table 3 have been obtained under actual working conditions obtaining at the Wandsworth Works throughout the period during which the tower purifiers have been in commission, but it is considered that these results can be improved in the future, *e.g.*, the first tower was changed because Christmas was approaching and it was not desired to perform this operation during that season, rather than because the tower had become fully fouled.

Table 3.—*Results Obtained at Wandsworth Works*

Tower No.	Date Discharged.	Analysis of Spent Oxide, Per Cent.	
		Water.	Pure Sulphur.
1	2	3	4
1	8th December, 1938	4·06	44·08
2	16th February, 1939	4·50	43·89

With the increasing knowledge being obtained from the practical working of this installation it is anticipated that a higher percentage of sulphur will be obtained than at the present time.

FINANCIAL ASPECT

Some remarks relating to the financial aspect of the installation may be of added interest.

For the last complete year prior to the installation of tower purifiers, *i.e.*, 1937, the cost per therm of purifying slightly under 21 mill. therms was 0·08239d.

The tower purifiers, working partly in conjunction with the original installation (cast iron rectangular boxes), were put into operation in June, 1938, and can therefore be said to have been in operation for approximately one half of that year. As a result of these purifiers the "all-over" cost per therm in 1938 was 0·06433d. on a total output of nearly 23 mill. therms.

Apart from the fact that it would have been impossible to purify the additional quantity of gas in the old purifiers, the "all-over" reduction in cost for the year as compared with 1937 represented £1,730 and this, as already mentioned, was produced in approximately one half of the year's working of the new installation:

22,994,103 therms, at 1937 price, 0·08239d.	= £7,894
" " , at 1938 price, 0·06433d.	= 6,164
Saving (half year).. ..	= £1,730

On the assumption that a proportionate saving will be effected when the tower purifiers have been in operation throughout a full year, a further sum of approximately £1,730 should accrue in reduction of costs, and it is estimated that the 1938 figure of £6,164 will be lowered to something approaching £4,434. This latter figure, in turn, would represent on the same output of gas a purifying charge of 0·0463d. per therm.

Of the total output from the Wandsworth Works it is estimated that approximately 75 per cent. will be purified by means of the tower purifiers, leaving the remaining 25 per cent. to be dealt with by the original installation, and the "all-over" average of 0·0463d. in respect of the total output would appear to be correctly allocated as between the two plants in the following manner:

Original plant, 0·08239d. × ¼	= 0·0206d.
Tower purifiers, 0·0343d. × ¾	= 0·0257d.
	0·0463d.

From the foregoing it will be seen that, based on the experience of the first six months' working, the process cost per therm of gas purified by the new plant will be well under 50 per cent. of the cost of dealing with the gas by means of the original purifiers.

This saving in costs is more than sufficient to pay interest and depreciation charges on the new plant which, based on the total capital cost of £58,000, and assuming a total output equivalent to that for the year 1938, represents 0·0445d. It will be seen that interest on capital has been taken at 4 per cent. which was a trifle above the rate ruling when the expenditure was actually incurred, whilst the sinking fund allocation is sufficient at 4 per cent. compound interest to write off the plant over a period of approximately 33 years.

The total charges for capital, etc., and the cost of purifying by the new installation are summarized below:

Capital and depreciation:	
Interest, 4 per cent. on £58,000	£2,320
Sinking fund, 1½ per cent. (at 4 per cent. compound interest)..	876
	£3,196
£3,196 ÷ 22,994,103 therms = 0·03336d.	
Capital and depreciation per therm with tower purifiers:	
0·03336d. × ¾	0·0445d.
Cost with tower purifiers:	
Process	0·0343d.
Capital, etc.	0·0445d.
	0·0788d.

When comparing the total cost with the cost in the original plant, it will, of course, be appreciated that no interest or depreciation charges are included in the latter instance.

By-Product Ammonia

by

P. PARRISH, M.Inst.Gas E., F.I.C., M.I.Chem.E.

(Manager, Phœnix Wharf Chemical Works, South Metropolitan Gas Company).

Communication No. 213

[Abstract]

SYNTHETIC AMMONIA AS A COMPETITOR OF BY-PRODUCT AMMONIA

With the development of processes for the manufacture of synthetic ammonia, dating from 1914 (but extending rapidly from 1926), and its conversion to ammonium products of various kinds, new factors were gradually introduced, as a result of over-production.

Eventually an international nitrogen cartel became a necessity. For some years past it has been necessary to fix quotas for synthetic ammonia manufacturers in various European countries, and compensation has had to be made to those continental and British factories which are compelled to adjust their output to the limitations of demand. Indeed, the structure of the British industry has altered, and the whole basis of sale is different from what it was in the period previously cited. Market prices today contemplate carriage to farmers' stations, commissions have to be paid, and there are other incidental expenses, which were unknown in the period from 1898 to 1922.

What the outcome of these influences has been can readily be visualized by an examination of Table I, in which figures are given representing the realization for by-product ammonia by the three metropolitan Gas Companies from 1918 to 1938, culled from Field's Analysis and other sources. In 1918 the total revenue derived from sulphate of ammonia and ammoniacal liquor by the three Companies in question was £441,427, representing 2s. 9·18d. per ton of coal carbonized. In 1938 this aggregate figure had fallen to £40,309, representing 2·08d. per ton of coal carbonized.

Table 2 gives details of the market prices of sulphate of ammonia for the last 15 seasons. It will be seen that the agricultural period 1931-32 was a peculiarly disastrous one for the Gas Industry, culminating in the lowest market price for sulphate of ammonia ever known, and involving the three metropolitan Gas Companies in a loss on sulphate of ammonia manufacture of £8,767, and a charge for the treatment of by-product ammonia of 0·48d. per ton of coal carbonized.

The two tables in question merit careful study, as their implications are important and far-reaching. Four aspects only need be enlarged upon here. These will be dealt with *seriatim*.

Spent Oxide

The revenue figures of the metropolitan Gas Companies relating to the manufacture of ammonium products derived from the treatment of by-product ammonia not only concern ammonia as such, but equally, the sulphur of spent oxide. Obviously, a charge for sulphuric acid has to be made to the ammonium products account, to cover the cost of manufacture of this mineral acid. The chemical works may be charged with the current market price of spent oxide, or with an arbitrary one, according to circumstances.

In any case, it has to be remembered that:

1·1 ton of 70 per cent. sulphuric acid is required in the manufacture of 1 ton of sulphate of ammonia, 25·71 per cent. ammonia.

Assuming a 96 per cent. efficiency in the manufacture of sulphuric acid from spent oxide, the number of units of sulphur required to manufacture one ton of 70 per cent. sulphuric acid will be:

$$\frac{32\ (\text{sulphur})}{98\ (\text{sulphuric acid})} \times 2{,}240 \text{ lb. per ton} \times \text{efficiency of process},$$

$$\frac{100}{96} \times \frac{70}{100}\ (70 \text{ per cent. acid})$$

$$= 533{\cdot}3 \text{ lb.}$$

One unit, or 1 per cent. = 22·4 lb.

Therefore, $\frac{533{\cdot}3}{22{\cdot}4} = 23{\cdot}80$ units per ton of 70 per cent H_2SO_4, at 96 per cent. efficiency.

Or for the manufacture of 1 ton of sulphate of ammonia containing 25·71 per cent. ammonia, as above:

23·80 units × 1·1 ton of 70 per cent. sulphuric acid per ton of sulphate of ammonia.

= 26·18 units of sulphur.

If, for example, one chemical works purchases its sulphur at 3d. per unit, and another at 6d. per unit, this means that the one buying at the cheaper price has a pecuniary ad-

TABLE I.—*Revenue Derived from Sulphate of Ammonia and Ammoniacal Liquor by the three metropolitan Gas Companies from* 1918 *to* 1938.

(Extracted largely from Field's Analysis).

Year	Gas Light and Coke Company				South Metropolitan Gas Company				Commercial Gas Company				Total			
	Revenue for Ammonia, £	Per Therm Sold, Pence	Per 1,000 cu.ft. Sold, Pence	Per Ton Coal Carbonized, s. d.	Revenue for Ammonia, £	Per Therm Sold, Pence	Per 1,000 cu.ft. Sold, Pence	Per Ton Coal Carbonized, s. d.	Revenue for Ammonia, £	Per Therm Sold, Pence	Per 1,000 cu.ft. Sold, Pence	Per Ton Coal Carbonized, s. d.	Revenue for Ammonia, £	Per Therm Sold, Pence	Per 1,000 cu.ft. Sold, Pence	Per Ton Coal Carbonized, s. d.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1918..	249,658	—	2·29	2 8·18	158,381	—	2·41	2 9·81	33,388	—	2·76	3 2·69	441,427	—	2·37	2 9·18
1919..	290,404	—	2·38	2 9·48	160,081	—	2·34	2 8·74	38,405	—	2·88	3 4·40	488,890	—	2·40	2 9·68
1920..	327,974	—	2·47	2 10·53	199,669	—	2·82	3 3·54	42,535	—	3·09	3 7·37	570,178	—	2·62	3 0·72
1921..	129,991	0·216	1·02	1 4·98	92,847	0·284	1·56	1 6·60	25,609	0·360	1·71	2 4·42	248,447	0·249	1·24	1 6·34
1922..	130,439	0·199	0·97	1 4·50	101,303	0·299	1·66	1 7·85	33,212	0·467	2·22	2 9·25	264,954	0·248	1·26	1 6·91
1923..	209,551	0·301	1·51	2 0·47	112,979	0·323	1·81	1 10·07	35,922	0·488	2·32	2 11·10	358,452	0·320	1·65	2 0·37
1924..	139,462	0·183	0·92	1 3·27	105,473	0·284	1·59	1 7·66	26,645	0·340	1·61	1 11·22	271,580	0·225	1·15	1 5·35
1925..	101,935	0·129	0·65	11·64	97,159	0·260	1·45	1 5·98	24,481	0·306	1·46	1 10·42	223,575	0·180	0·93	1 2·66
1926..	79,003	0·084	0·42	8·69	69,878	0·187	1·05	1 1·37	19,714	0·239	1·13	1 6·95	168,595	0·121	0·62	10·98
1927..	96,563	0·100	0·50	8·77	63,175	0·168	0·94	11·99	19,207	0·233	1·12	1 4·70	178,945	0·126	0·64	10·27
1928..	86,478	0·088	0·44	7·68	56,622	0·152	0·85	10·87	22,029	0·248	1·23	1 5·04	163,129	0·114	0·58	9·24
1929..	78,414	0·077	0·39	6·78	50,371	0·128	0·72	9·29	19,781	0·248	1·24	1 4·87	148,566	0·099	0·51	8·18
	Loss															
1930..	16,047	0·016	0·08	1·35	36,239	0·093	0·52	6·95	13,038	0·174	0·87	11·70	33,230	0·023	0·12	1·82
	Loss															
1931..	5,237	0·005	0·03	0·45	10,531	0·026	0·15	1·94	10,979	0·146	0·73	10·02	16,273	0·011	0·06	0·90
	Loss				*Loss*								*Loss*			
1932..	4,505	0·005	0·02	0·37	8,111	0·021	0·12	1·57	3,849	0·054	0·27	3·64	8,767	0·006	0·03	0·48
					Loss											
1933..	1,545	0·001	0·01	0·13	836	0·002	0·01	0·17	4,192	0·060	0·30	4·02	4,901	0·003	0·02	0·28
1934..	1,957	0·001	0·01	0·15	11,680	0·034	0·19	2·51	6,296	0·092	0·46	6·18	19,933	0·014	0·07	1·09
1935..	20,644	0·020	—	1·65	8,740	0·025	—	1·89	5,351	0·081	—	5·48	34,735	0·024	—	1·92
1936..	15,833	0·014	—	1·14	16,773	0·048	—	3·62	6,149	0·094	—	6·32	38,755	0·026	—	1·99
1937..	6,753	0·006	—	0·47	24,977	0·078	—	5·54	4,876	0·076	—	5·11	36,606	0·026	—	1·86
1938..	7,642	0·010	—	0·54	26,698	0·080	—	6·14	5,969	0·100	—	6·55	40,309	0·070	—	2·08

TABLE 2.—*Market Prices of Sulphate of Ammonia, Delivered in 6-Ton Lots, 20·6 Per Cent. Nitrogen, to Farmers' Stations.*

Year	January	February	March	April	May	June	July	August	September	October	November	December
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1	2	3	4	5	6	7	8	9	10	11	12	13
1924	—	—	—	—	—	—	14 0 0	14 0 0	14 2 0	14 4 0	14 6 0	14 8 0
1925	14 10 0	14 12 0	14 14 0	14 14 0	14 14 0	12 5 0	12 5 0	12 5 0	12 7 0	12 9 0	12 11 0	12 13 0
1926	12 15 0	12 18 0	13 1 0	13 1 0	13 1 0	13 1 0	13 1 0	13 1 0	11 7 0	11 9 0	11 16 0	11 18 0
1927	12 0 0	12 3 0	12 6 0	12 6 0	12 6 0	12 6 0	12 6 0	9 18 0	10 0 0	10 2 0	10 5 0	10 8 0
1928	10 11 0	10 13 0	10 13 0	10 13 0	10 13 0	10 13 0	10 13 0	10 0 0	10 0 0	10 2 0	10 5 0	10 8 0
1929	10 11 0	10 13 0	10 13 0	10 13 0	10 13 0	10 13 0	10 13 0	9 9 0	9 9 0	9 11 0	9 14 0	9 17 0
1930	10 0 0	10 2 0	10 2 0	10 2 0	10 2 0	10 2 0	10 2 0	8 17 0	8 19 0	9 1 0	9 3 0	9 5 0
1931	9 8 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	{6 10 0 / 6 0 0}	{5 10 0 / 6 5 0}	6 5 0	6 10 0	6 15 0
1932	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	5 5 0	5 5 0	5 5 0	5 5 0	6 0 0	6 2 6
1933	6 5 0	6 7 6	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 15 0	6 17 6	7 0 0
1934	7 2 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	6 14 6	6 16 0	6 17 6	6 19 0	7 0 6
1935	7 2 0	7 3 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	6 14 6	6 16 0	6 17 6	6 19 0	7 0 6
1936	7 2 0	7 3 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	6 14 6	6 16 0	6 17 6	6 19 0	7 0 6
1937	7 2 0	7 3 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 3 6	7 5 0	7 6 6	7 8 0	7 9 6
1938	7 11 0	7 12 6	7 14 0	7 14 0	7 14 0	7 14 0	7 14 0	7 3 6	7 5 0	7 6 6	7 8 0	7 9 6
1939	7 11 0	7 12 6	7 14 0	7 14 0	7 14 0	7 14 0	7 14 0	—	—	—	—	—

vantage of 26·18 × 3d. per unit = 6s. 6·6d. per ton of sulphate of ammonia.

Price of Fuel

Another factor is the price paid for fuel. This, usually, consists of breeze, where it can be obtained in adequate quantity. Manifestly ideas vary, however, as to its market price. The quality also varies widely. In the absence of a standard price for a reasonable standard quality in an assigned locality, obviously there can be no uniform comparison.

Demand for New Methods

Emerging from a consideration of Field's Analysis figures for 1932, it will be found that practically all the Undertakings, whether Companies or Corporations, suffered a loss from the manufacture of sulphate of ammonia during this year, and it became evident that the problem of the treatment of gas liquor was one demanding a new approach, and, indeed, called for new methods.

Methods of Sale

Potash and phosphatic fertilizers and mixtures containing nitrogen, phosphorus and potassium (N.P.K.), are sold on the basis of a price f.o.r. makers' works, but in the case of nitrogenous fertilizers the selling price covers delivery to farmer's station.

Whatever advantages such a method of sale possesses, it is certain that a false impression is given to the general public of the price which Gas Works are realizing for sulphate of ammonia. No trader would willingly convey to his clientèle, or to the general public, an exaggerated idea of the price being realized for any commodity. Motor cars are sold not at £300, but at £299; or not at £250, but at £249; or not at £200, but at £199. Similarly, drapery and hosiery are sold not at 3s., but at 2s. 11¾d. Woolworth's retail sulphate of ammonia in sixpenny lots, about 2 lb. The practice of the industry has been to sell 7 lb. lots at 1s. 6d.

In this connexion it should be noted that the total world consumption of 41,929,500 tons of fertilizer materials contained 8,561,750 tons of plant food in the ratio of 1 N_2 to 1·83 P_2O_5 to 1·036 K_2O.[5]

PIONEERING EFFORT IN THE MANUFACTURE OF CONCENTRATED GAS LIQUOR

From 1929 to 1931 much attention was given to the design of concentrated gas liquor plants, but it was not until the end of 1931 that an opportunity was afforded of designing and putting into operation an automatically-operated concentrated gas liquor plant for a relatively small Works, carbonizing only about 3,500 to 4,000 tons of coal per annum. The reason for selecting this works was that during the night shift one stoker only constituted the personnel. He was called upon to attend to the exhauster, the district requirements, and all the other matters incidental to the operation of a small Gas Works.

It was felt that if an automatically-operated concentrated gas liquor plant could be made to function satisfactorily at a small Works, there would be no difficulty in establishing this method a tother and larger Works. Mr. R. J. Philp, Engineer and Manager of North Berwick Corporation Gas Department, indicated in some detail in a contribution to the North British Association of Gas Managers,[5] the particulars of this initial attempt, and the success which had accompanied its operation.

This plant was of the Thorncliffe-Baldurie type, and consisted of

(*a*) A special still, 18 in. in diameter, with 11 sections, 9 in. in depth, fitted with bubbling hoods, overflow pipes and access doors for cleaning purposes.

(*b*) A preheater and condenser of the concentric tube construction, having tubes of 1½-in. bore by 6 ft. 7 in. in length, and external tubes of 3-in. bore by 6 ft. in length, connected by suitable headers.

(*c*) An overhead cast iron storage tank, 12 ft. × 8 ft. × 4 ft., for concentrated gas liquor.

(*d*) A scrubber to absorb the ammoniacal air discharged from the concentrated gas liquor tank.

What was contemplated, in this design, was that the gas liquor should be pumped from the feed supply tank to the preheater and thence to the still, the gases from the still being used to preheat the liquor, and finally condensed and gravitated to the concentrated gas liquor storage tank. A water supply was fixed to the condenser, but in actual practice little water was used. The pump was of the rotary type, steam-driven.

On the pipe connecting the still to the preheater there was fitted an "Arca" thermo-relay and pressure regulator, actuated by the temperature of the vapours leaving the still, so that a constant still-head temperature could be maintained. On the steam inlet to the still was fixed an "Arca" control valve, the function of which was to maintain a constant pressure of steam. The quantity of steam passing the steam valve was a measure of the liquor throughput of the plant, and the pressure gauge on the controlled steam line could actually be calibrated in terms of ammoniacal liquor per hour.

No plant is entirely automatic unless it is foolproof under any condition that might arise. If pressure accumulated in the condenser, due to the formation of ammonium bicarbonate, it was transmitted through a relay to the liquor valve, which shut immediately. The steam valve remained open, however, permitting steam to pass through the preheater and condenser, the blockage being thus automatically removed. The pressure then fell, and the liquor valve automatically re-opened, the plant reverting to normal operation.

If the blockage, for some reason, had become so permanent that this automatic steaming did not remove it, pressure in the still base would increase. Another pressure relay, connected to the steam valve, was so arranged that if a predetermined pressure was exceeded, the steam valve would close, and the plant would automatically shut down.

[5] *Encyclopædia Britannica*, 1939, p. 257.

[5] *Gas J*, 1932, **199**, 645.

Mr. R. J. Philp wrote to the Author in April, 1939, as follows:

"The concentrated gas liquor plant is operating very satisfactorily. Below I give details of the repairs which have been carried out since the plant was installed in 1931:

	£	s.	d.
October, 1932—Regulating valves (Arca)	3	5	6
December, 1934—Repairs to water regulators (Arca)	1	2	6
March, 1935—Cones for regulators (Arca)	1	6	0
August, 1936—Glass tube on tank		5	0
December, 1936—Iron stopcock—testing pipe ..		2	6
July, 1937—New float in effluent discharge chamber	1	18	0
March, 1938—Repairs to valve and pressure relay ..	2	12	6
	£10	12	0

It was thought desirable to give you the details of the ordinary repairs, as I regard them as very small, and you might consider that I had given you an estimate.

We have despatched since the plant was started, 453 tons, 13½ cwt. of concentrated gas liquor. This represents, for repairs, 5·61d. per ton. During the first year or so after the plant was started, we made concentrated gas liquor 16 per cent. ammonia by weight. Recently, to avoid ammonium bicarbonate difficulties, we have reduced the strength to about 13 per cent. ammonia by weight.

Regarding the working of the plant: one man puts the plant into operation between other duties, and glances at it occasionally from 6 a.m. to 5 p.m.: after 5 p.m. we have only one man in the Works until 9 p.m., when his shift finishes. The night stoker arrives at 9 p.m., and works until 5 a.m., so that there is only a stoker in charge of the whole Works from 5 p.m. until 6 a.m. the next morning. The stoker makes a visit to the plant from time to time, and generally it is working normally. Should a blockage occur which persists, the stoker shuts down the plant, and attention is given to this by the day-man when he arrives at 6 a.m.

It is understood that in one or two Works where vertical retort gas liquor only is used, they have had to renew a number of condenser pipes. So far I have not had to renew any."

In 1933 it was found desirable to deal with the permanent gases leaving the scrubber, and a purifier was installed for the absorption of H_2S. A cover was also provided to the gas liquor tank, and a steam coil was installed in the concentrated gas liquor tank, in order to maintain a suitable temperature for loading.

Several plants of the foregoing type were erected, of varying capacities, and all have worked in a satisfactory manner and afforded a means by which concentrated gas liquor containing 15 per cent. of ammonia by weight could be produced for about 8s. per ton. Two plants of the Thorncliffe-Baldurie type were erected at coke ovens in the Sheffield area; one at Manvers Main, where, without labour, concentrated gas liquor containing 16 per cent. of ammonia by weight is being manufactured from a gas liquor throughput of up to 67,200 gal. per day, and duplicate installations were erected at the Barnsley and District Coking Company's works, each of which was capable of dealing with 33,600 gal. of gas liquor per day.

Mr. W. Green, commenting on these installations in the course of a discussion on a Paper by J. Bishop,[6] remarked:[7]

". . . He thought Mr. Bishop had not made the most of his case in regard to the merits of the modern type of plant. It was very well laid out and the space concerned was conserved to a very great extent when compared with the old type of plant which worked during the war period twenty years ago. It was a type of plant in which huge condensers were used. The two were of the same size and the first simply acted as a de-hydrator. In the present plant the still itself was used to fractionate the ammonia vapours, leaving the correct ammonia to go forward to the final condenser. There was another point where Mr. Bishop might have been more liberal with them and that was in regard to the efficiency of manufacture. It was a point that had to be considered because if any ammonia went past the condenser, to deal with it and prevent it going back to the gas there had to be a final scrubbing apparatus to remove such ammonia. That, of course, was controlled by the outlet temperature of the condenser and the lower that could be kept the less ammonia had to be dealt with afterwards."

[6] "The Manufacture and Economics of Concentrated Gas Liquor as Applied to Coke Oven By-Product Recovery Plant", *Gas World* (Coking Section), 6th February, 1937, p. 11.

[7] *Ibid.*, p. 17.

MANUFACTURE OF CONCENTRATED GAS LIQUOR

As time elapsed it was evident that railway companies were reaping a rather more satisfactory reward for the conveyance of concentrated gas liquor than was warranted, having regard to the scanty profits that Gas Undertakings were realizing.

It was felt that as much sulphur as possible, in the form of ammonium sulphides, should be transported in the concentrated gas liquor, and equally, that the concentration of ammonia should be the highest possible, compatible with railway rates classifications. It was known that if the specific gravity fell below 1·00, classification 6 obtained, and that much higher rates applied, whereas with concentrated gas liquor of a specific gravity above 1·00, classification 3 applied. Further, it was realized that any product falling below a specific gravity of 1·00 was essentially concentrated ammonia liquor, and not concentrated gas liquor, and that the partial pressure of the ammonia in the former product was appreciably higher than that of concentrated gas liquor.

Experience of concentrated ammonia liquor during the Great War led to the avoiding of its manufacture, as such a product could only be obtained by effecting practically complete decarbonation. It was known that this involved a high steam consumption, and that loss was entailed in the transport of the ultimate product. There can be no doubt that concentrated gas liquor is a more economic product to manufacture and transport, and none other should be made.

At this time (1933-34), experience of the operation of concentrated gas liquor plants, and of concentrated gas liquor, was rapidly extending. It could be determined with reasonable accuracy, from the characteristics of the gas liquor, whether concentrated gas liquor containing (*a*) 15 per cent. of ammonia by weight, or (*b*) 20 per cent. of ammonia by weight, could be made without partial decarbonation. Indeed, it was becoming known that the characteristics of a gas liquor afforded an index of the methods practised in the carbonization of coal. Where straight coal gas was manufactured, of a high calorific value, say 550 B.Th.U. per cu.ft., the CO_2 content of the gas could generally be maintained between 2 and 2½ per cent., and the NH_3/CO_2 ratio was such that concentrated gas liquor of about 19 to 20 per cent. ammonia by weight could be made without partial decarbonation.

Where steaming occurred (and steaming, for the most part, appeared to be pursued in a peculiarly variable manner), the CO_2 content of the crude gas may increase to 6 per cent. or even more, and the NH_3/CO_2 ratio of the gas liquor was such that concentrated gas liquor containing 19 to 20 per cent. ammonia by weight could not be manufactured without partial decarbonation. This additional cost sensibly increased the costs of manufacture.

Whether or not a gas liquor of given characteristics called for partial decarbonation, in the production of concentrated gas liquor of 20 to 22 per cent. ammonia by weight, depended largely on the NH_3/CO_2 ratio. If this were of the order of 1·0: 1·36, the ratio of the normal ammonium carbonate being

$$\frac{CO_2}{2(NH_3)} = \frac{44}{34} = 1{\cdot}3$$

it could safely be concluded that partial decarbonation was unnecessary.

On the contrary, where the NH_3/CO_2 ratio was of the order of 1·0: 1·6 to 1·0: 1·7, it was certain that partial decarbonation of the gas liquor was essential to the production of a concentrated gas liquor containing 20 to 22 per cent. ammonia by weight.

Moreover, if decarbonation proceeded too far, beyond an NH_3/CO_2 ratio of 1·0: 1·25 to 1·0: 1·30, there would be an increase of the ammonium hydrate content of the concentrated gas liquor. If this exceeded 1·5 to 3·0 per cent., there was a possibility of the crystallization of ammonium carbonates due to depression of the solubility of the salts, in

obedience to the rule that "a substance introduced into a solution with another solute without reacting with it to form any complex ions, commonly decreases the solubility of the said solute." The recognition of these broad principles led to the next development at the Works of the Lea Bridge District Gas Company, to which reference will be made later.

Early in 1934 two Thorncliffe-Baldurie concentrated gas liquor plants of the original type, were erected in the south of England, and it was demonstrated that concentrated gas liquor of 20 per cent. ammonia by weight could be produced with this type of plant, without the necessity for decarbonation. This was due to the fact that the NH_3/CO_2 relationship of the gas liquor was of the order of 1 : 1·3.

Subsequent working has revealed that concentrated gas liquor of an average of 20 per cent. ammonia by weight can be manufactured without partial decarbonation, thus vindicating the accuracy of what was foreshadowed.

The cost of the manufacture of concentrated gas liquor in a vapour phase plant is given in Appendix 5, and affords, in a striking way, a measure of the progress which has been made, as a result of cumulative experience, in the economic production of concentrated gas liquor.

BRIEF SUMMARY OF EXPERIENCE

There is no hard-and-fast rule governing the adoption of a concentrated gas liquor plant; the type must vary with the characteristics of the gas liquor, and with certain local requirements; that no standard or uniform plant can be universally applicable; and that it is wrong in principle to suggest one type of plant for all the varying qualities of gas liquor that it may be desirable to convert to concentrated gas liquor. There is much evidence for the view that the most flexible form, which more nearly fulfils the varied requirements and indeed is the most economical form the viewpoint of steam consumption, is the vapour phase plant, because this can be adapted for the treatment of varying qualities of gas liquor.

Many years' experience of the design and operation of concentrated gas liquor plants, automatically-controlled, reveals that the characteristics of the gas liquor vary at most Gas Works, with (*a*) variations of the quality of the coal carbonized, (*b*) the control exercised, and (*c*) the type of plant. Similarly, the operation of concentrated gas liquor plants differs not only with such changes in the quality of the gas liquor, but with its temperature, which may be as low as 10° C. in the winter, and 24° C. in the summer. Equally, it is known that the temperature of the cooling water employed varies between 10° C. in the winter, and 24 to 26° C. in the summer.

It is essential, therefore, that concentrated gas liquor plants should not only be of adequate design to afford the necessary flexibility, but should provide equipment to admit of modification of control to meet the varying conditions that are likely to be encountered. The condenser may require little, if any, water in winter. It may even require to be temporarily protected with easily-detachable boarding, since there are two influences likely to obtain; firstly, the gas liquor may be cold enough to effect the necessary cooling of the steam-ammonia stream, and, secondly, the exposed position of the condenser to atmospheric influences may call for the temporary protection suggested. In the summer months the temporary wooden protection must be detached and removed, as cooling water will certainly be necessary. Many plants have operated for six or seven years with little wear and tear; others have been the subject of corrosive influence. It would appear that where corrosion occurs, the gas liquor contains abnormal quantities of ammonium cyanide, which has not had time to react with the precipitated sulphur to form thiocyanate.

Generally speaking, there are two factors operating; one arises from the conditions of carbonization, in which ammonium cyanide and ammonium ferrocyanide are produced to an unusual extent, and the other is incidental to the storage conditions, namely, absence of adequate storage. Gas Works suffering in the way described can largely overcome the corrosion of their concentrated gas liquor plants by aerating the gas liquor and/or using powdered sulphur to fix the ammonium cyanide as ammonium thiocyanate, or they can employ ammonium polysulphides for this purpose. The corrosion referred to is largely confined to the still-head and preheater inner tubes. Obviously these tubes should be arranged in such a way as to admit of easy renewal. This is impossible where multi-tubular coolers are adopted. It should be noted that the corrosion occurs not from the inside of the tubes, due to the gas liquor being preheated, but rather from the outside, where the tubes first meet the steam-ammonia stream.

Concentrated gas liquor is not infrequently associated with tar, phenolic bodies and pyridine bases, and these have to be separated from time to time. There also accumulates at the central chemical works after, say, a year's storage, a not inconsiderable quantity of iron sulphide, and this has to be physically removed. It has been found advantageous to use sectional-plated cast iron shallow tanks, the tops of which can be readily removed, so that the accumulations can be discharged without inconvenience being caused by fumes.

Generally speaking, concentrated gas liquor contains 20 to 22 per cent. of NH_3, 13 to 23 per cent. of CO_2 and 1·6 to 12 per cent. of H_2S. An average H_2S content is 4 per cent.

THE ESTABLISHMENT OF A CENTRAL SCHEME

If Gas Undertakings are to receive the maximum benefit under a central scheme they must ally themselves with an existing chemical works, geographically well-situated, having a sulphuric acid plant of flexible capacity, and preferably having a demand for sulphur material and ammonium products. Their production of sulphur material, spent oxide, should be no less the subject of sale than concentrated gas liquor. Such an arrangement would appear to be essential, as the two products are inter-dependent, and will become increasingly so as time elapses.

The Directors of the central chemical works must be prepared to purchase the sulphur material, spent oxide, on a sliding scale basis, dependent on the price realized in this country for the sulphur content of pyrites, bearing in mind that most pyrites are arsenical, whereas spent oxide is generally commercially free from arsenic. Equally, the Directors must be prepared to adopt a sliding scale basis of purchase for concentrated gas liquor, dependent on (*a*) variations in the market price of sulphate of ammonia in 6-ton lots, delivered to farmer's station, as declared from time to time by the British Sulphate of Ammonia Federation, Limited, and (*b*) the ammonia content of the concentrated gas liquor. The Directors of the chemical works, in fixing such sliding scale prices, must be prepared to allow a reasonable percentage of their reduction of standing charges arising from increased make of products, as applying to the manufacture of sulphuric acid and ammonium products, to be assigned for distribution to the Gas Undertakings. Such sum can be appraised initially, and commuted into the sliding scale figures.

Failing such an arrangement, there should be participation in the surplus profit by the Gas Undertakings on, say, an equal basis, after a predetermined profit has been realized by the chemical company. A formula can easily be established, by mutual consent, for the determination of the profits, and mutually-appointed auditors can ascertain this figure, if need be.

The expediency of adopting co-operative schemes, on the lines of those operating in the tar trade, is doubtful.

The radius of the area within such a central chemical works should operate may well be 70 to 100 miles or more, dependent on the number and size of the Gas Works within the proposed area, and whether transportation of concentrated gas liquor can be effected by canal, river, sea or rail. Ultimately, with a view to minimum transport charges being incurred, there should be well-defined zones of operation, and encroachment on such zones should be forbidden. If ammonium sulphate should be made, and utilized at the factory of the central chemical company, in the form of N.P.K. fertilizers, the cost of bags, selling expenses, transport charges and many significant items of cost of this character can be avoided. These savings will ultimately be reflected in increased profits realized by the Gas Undertakings.

If the central chemical works is gaining the combined advantage of (*a*) propaganda, and (*b*) compensations accorded under an international cartel to firms which are limiting their

production, it is clearly poetic justice that some contribution should be made to the representative body, the British Sulphate of Ammonia Federation, Limited.

In this connexion, it should be remembered that synthetic ammonia plants were erected in many European countries, primarily as a measure of defence. Synthetic ammonia can be readily converted to nitric acid, and nitration processes are indispensable to the production of high explosives. It is true that synthetic ammonia can be utilized in periods of peace for the production of fertilizers, but there is necessarily a vast disparity between the requirements for defence and the needs of agriculture in normal times. It is important that this factor should be borne in mind in determining what is the justifiable basis of compensation for an agreed reduction of capacity under the conditions of a cartel. Obviously, the difference of capacity between defensive requirements and agricultural needs should be a charge to the country concerned, and should not be borne by other parties to the cartel.

TABLE 5.—*Financial Situation of Gas Undertakings Prior to and After Joining a Central Chemical Works Scheme*

—	Prior to Joining: Debit Balance on Gas Liquor Treatment, £.	Now Realizing, £.
1	2	3
1. Corporation Gas Undertaking ..	6,000	Small profit
2. Gas Company	2,000	Slight profit
3. Gas Company	815	248
4. Gas Company	2,000	400* (Estimated)
5. Gas Company	700	350
6. Gas Company	1,700	400

* See *Gas J.*, 1938, **221**, 958.

Several central schemes are operating at the present time, and it is not improbable that others will be established later. The Company with which the Author is connected started a scheme several years ago, and it has now grown to such dimensions as to involve the treatment of over 15,000 tons of concentrated gas liquor annually. This scheme, although not quite so comprehensive as has been indicated previously, provides in the sliding scale prices for participation by the Gas Undertakings in the reduction of standing charges. The scheme is working satisfactorily, to the advantage alike of the Gas Undertakings and the central chemical works. As evidence of this, the figures in Table 5 are of interest.

Many other examples of the same order can be cited.

MANUFACTURE OF SULPHURIC ACID FROM THE HYDROGEN SULPHIDE OF SATURATOR GASES

Deliveries of concentrated gas liquor began to increase so rapidly at the chemical works with which the Author is connected, that it became necessary, early in 1934, to consider the form which a new sulphuric acid plant should take, to deal exclusively with the saturator gases.

An investigation of the Metallgesellschaft Aktiengesellschaft contact process, using a wet vanadium catalyst, was made first, but this process proved to be too expensive for adoption, particularly as regards capital expenditure. A "nitrose" process, involving a tower system, was then designed, as representing the best form of plant. Figure 5 shows a diagrammatic elevation of the plant.

STAGES OF THE PROCESS

The stages of the process, represented in their simplest form, are as follows:

(*a*) Combustion of hydrogen sulphide:

$$H_2S + 1\tfrac{1}{2}O_2 = SO_2 + H_2O.$$

(*b*) Oxidation of sulphur dioxide by the atmospheric oxygen, in the presence of oxides of nitrogen as a catalyst, and water vapour:

$$SO_2 + \tfrac{1}{2}O_2 + H_2O = H_2SO_4.$$

(*c*) Oxidation of the nitric oxide:

$$2NO + \tfrac{1}{2}O_2 = N_2O_3.$$

This is essentially a time reaction, as seen from Figure 6, and such oxidation occurs in a large void Gaillard-Parrish tower chamber.

(*d*) Absorption of N_2O_3 in cold 80 per cent. H_2SO_4 in the Gay-Lussac towers:

$$2H_2SO_4 + N_2O_3 = 2HNSO_5 + H_2O.$$

(*e*) Denitration of the nitrous acid in the Glover towers by the burner gases arising from the combustion of H_2S:

$$2HNSO_5 + SO_2 + 2H_2O = 3H_2SO_4 + 2NO.$$

(*f*) Nitrogen oxides are derived from the oxidation of ammonia. (See Section XI of the Paper for the reactions).

CAPACITY OF PLANT

The plant was designed in such a way as to be flexible. It was intended to produce 75 tons of 70 per cent. acid per week, and subsequently to increase this to 100-120 tons per week, by the introduction of a waste heat boiler, intended to effect thermal interchange between the hot burner gases—between 750 and 760° C.—and zero hardness water, in the

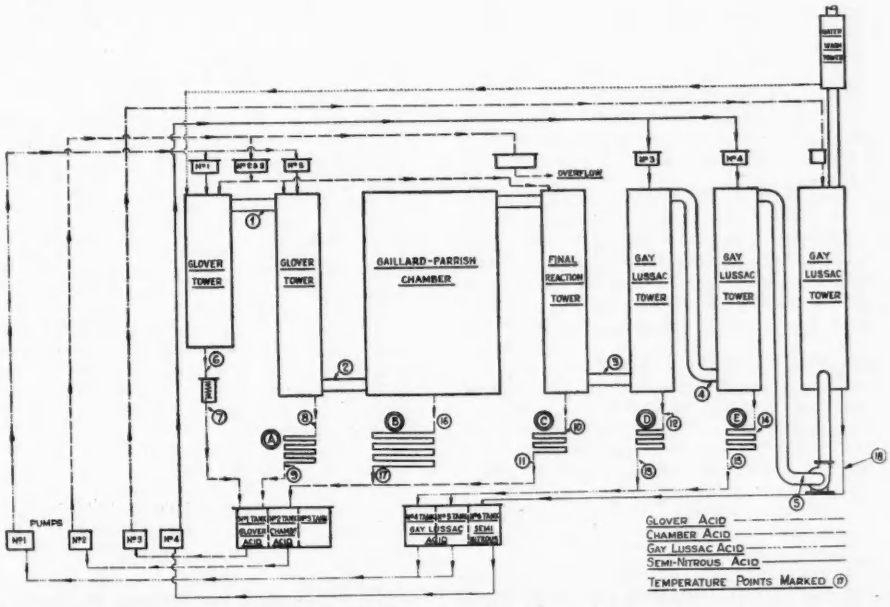


FIGURE 5.—*Diagrammatic Elevation of Sulphuric Acid Plant Using the H_2S of Saturator Gases.*

production of steam. A reduction of the temperature of the burner gases will admit of an increase of capacity of the plant.

Volume of Gases

The following data relate to the quantity of gases to be dealt with in the plant at the outset:

(*a*) Production:
75 tons of 70 per cent. H_2SO_4 per week.
= 52·5 tons of monohydrate sulphuric acid.
= 7·5 tons of monohydrate sulphuric acid per day of 24 hr.
= Approximately 2·5 tons of sulphur per day.
= 0·104 ton of sulphur per hr.
= Approximately 224 lb. of sulphur per hr.
= Approximately 448 lb. of SO_2 per hr.
448 lb. of SO_2 per hr. × 5·6 cu ft. per lb. = 2,508 cu.ft. SO_2 per hr.

(*b*) $\frac{2{,}508 \text{ cu.ft.}}{6 \text{ per cent. } SO_2}$ = 41,810 cu ft. per hr. of saturator gases at N.T.P.

(*c*) It was anticipated that the temperature of the burner gases entering the Glover tower would be 750° C.

(*d*) 41,810 cu.ft. × $\frac{1{,}023}{273}$ (factor, say, 3·7) = 154,697 cu.ft. per hr., or say, 43 cu.ft. of hot gas, at 750° C., per sec.

Composition of Plant

(i) H_2S burner, supplemented by a rotary mechanical sulphur burner.
(ii) Ammonia oxidation plant, using crude liquor ammonia.
(iii) Two Glover towers.
(iv) One Gaillard-Parrish tower chamber, irrigated with chamber acid from a turbo-disperser. (This chamber serves a double purpose, (*a*) completing the manufacturing process, and (*b*) affording time contact for the oxidation of the nitric oxide.)
(v) One scrubber tower, to remove the weak acid.
(vi) Three Gay-Lussac towers.
(vii) One water-wash tower.
(viii) Necessary acid stock cisterns—top and bottom.
(ix) Acid pumps, with oil diaphragm, of (*a*) plunger and (*b*) piston types.
(x) Glover acid coolers.
(xi) Concentric coolers for the acid from all the towers.
(xii) Central temperature control.
(xiii) Regulus metal fan, for draught.

As the sulphate of ammonia units only work 6½ days per week, coupled to the H_2S burner is a rotary mechanical sulphur burner, which is brought into operation 2 hr. before the shutting-down of the sulphate of ammonia units. Sicilian or Texas Gulf sulphur is burnt, and as the burner can be brought to capacity in less than 2 hr., it is possible to ensure continuity of sulphuric acid manufacture, and to maintain the brickwork of the H_2S burner at such temperature as will effect ignition of the saturator gases when operation of the sulphate of ammonia plants is resumed, after the 16 hr. inactivity on Sundays.

Combustion of sulphur ceases with the resumption of the supply of the H_2S-containing gases. Before the latter are again introduced to the H_2S burner, tests are made to determine that the air is displaced from the mains and the ring main. Saturator gases are not introduced until a test shows that the oxygen content is as low as 2 per cent. There has never been any hitch with the combustion of the saturator gases, and the plant works uniformly, and almost automatically.

The plant has operated for more than three years, and the consumption of ammonia is about 1 per cent. on the sulphur equivalent of the acid made. The cost of manufacture of sulphuric acid by this process is phenomenally low. A special system of circulating the various "nitroses" has been adopted. The acid from the various towers is water-cooled, and this constitutes a unique feature. The sulphuric acid produced is water-white, and contains traces of iron. All the indications are that the wear and tear will be relatively small.

The first Glover tower is capable of concentrating to 80 per cent. sulphuric acid all the chamber acid fed to and made in the Glover towers and other portions of the plant. Indeed, the water-wash, containing small percentages of sulphuric acid and nitrogen oxides, up to 20 gal. per hr., can be satisfactorily treated in this tower.

With the change at the week-ends from the combustion of hydrogen sulphide to that of brimstone, temperature conditions obviously vary. The burner gases reach the stalk at appreciably higher temperatures when a gaseous medium like saturator gases is used, than when solid brimstone is employed. Usually the sulphur burner is brought into commission at 4 a.m. on Sunday, and combustion in it is discontinued at 11 p.m. the same evening.

A shift worker operating another process is responsible for the working of the plant, which lends itself to easy control.

MANUFACTURE OF DRY NEUTRAL SULPHATE OF AMMONIA OF SATISFACTORY CRYSTAL SIZE FROM CONCENTRATED GAS LIQUOR

The manufacture of sulphate of ammonia from concentrated gas liquor and sulphuric acid should not constitute an insuperable difficulty. The standard type of sulphate of ammonia plant clearly calls for modification, or better still, new plant of suitable design should be installed.

The concentrated gas liquor should be preheated by the hot waste gases from the saturator to a temperature of, say, 90° C., and the still-head temperature should be maintained at not less than 85-86° C., if a suitable and inexpensive carrier for the ammonia is to be provided, and the necessary velocity through the perforations of the cracker pipe, essential for the support of the crystals during formation, is to be obtained. Difficulties will be encountered from "gas locks", unless a suitable form of preheater is arranged. Other special provisions are also necessitated.[10]

The tendency for many years has been for saturators of unwieldy dimensions to be erected, and arranged in a way rendering support of the crystals almost impossible. Nine or ten years ago the designers of saturators for the treatment of synthetic ammonia were the worst offenders in this respect. Saturators were apparently modelled on the lines of by-product coke oven practice, and no regard was given to the chemical engineering data so essential for an appreciation of what was required.

The crystals first formed in the manufacture of sulphate of ammonia are small. Given the correct starting conditions, they will grow if they are suitably suspended in the mother liquid from which they are first formed for a given time, and if the temperature and free acid content of the mother liquor are maintained reasonably uniform at all times. The questions that naturally arise are:

(*a*) What are the correct starting conditions when sulphate of ammonia has to be made from by-product or synthetic ammonia?
(*b*) How can crystals be maintained in suspension in the mother liquor from which they are in process of formation?
(*c*) How long have the crystals to remain in suspension before they attain the correct size?
(*d*) How can the temperature and free sulphuric acid content of the mother liquor in the bath be maintained reasonably uniform at all times?
(*e*) Why do the temperature and free acid content of the mother liquor in the bath affect the size of the crystals?

Given the usual quality of sulphuric acid available in Great Britain and European countries, there should be no difficulty in the production of large-sized crystals, as such acid invariably contains 0·01 to 0·015 per cent. of ferrous iron. By-product sulphate of ammonia, manufactured from pyrites or spent oxide acid, has, as a nucleus, a quasi-alum (ferrous ammonium sulphate). With controlled development, the crystals ultimately produced should have a screen analysis as follows:

Remaining on 30 × 30 I.M.M. screen	..	70 to 75 per cent.
Passing 50 × 50 „ „	..	8 to 10 per cent.
Passing 80 × 80 „ „	..	2 to 3 per cent.

Accepting the foregoing postulates, it is now possible to reply to the questions which have been posed.

Correct Starting Conditions

In starting a saturator where by-product ammonia or synthetic ammonia is to be used, it is necessary to commence

[10] British Patent No. 437,681.

with a saturated solution of ammonium sulphate with a free sulphuric acid content of 5 per cent., having a temperature of 105° C. This solution should occupy the normal level of the saturator, to which reference will be made later.

The solution in question can best be obtained at the commencement by dissolving ammonium sulphate in water in the mother liquor tank until saturation is reached. Sulphuric acid must then be added until a content of 5 per cent. H_2SO_4 is attained. Steam must be applied, and the temperature raised to 100° C., and a further quantity of ammonium sulphate and sulphuric acid added to adjust for the dilution arising from the condensed water resulting from the application of steam.

When the adjustment has been made, the requisite quantity of solution, saturated with sulphate of ammonia having a 5 per cent. content of sulphuric acid, and at a temperature of 105° C., will be introduced to the normal level line of the saturator.

How Crystals can be Maintained in Suspension

To maintain the crystals in suspension, it is necessary to have a saturator of special size and special design. With the saturators now in operation there is a definite relationship between the volume of liquor in the body of the saturator and the volume of liquor in the well at the foot of the saturator. Moreover, the distribution of steam and ammonia is maintained at a certain velocity, which is sufficient to support the newly-formed crystals in a state of suspension during the period required for their growth, and is insufficient to cause any fracture of the crystals. Similarly, the crystals in the heavier magma, due to super-saturation, which have a tendency to deposit in the well, are also prevented from falling out of suspension by the provision of suitable means.

Hitherto, few have recognized the importance of the following relationships:

(*a*) The quantity of solution in the saturator in relation to the quantity of solution in the well.
(*b*) The significance of a specific velocity through the distribution pipes.
(*c*) The importance of a specific arrangement of distribution pipes.
(*d*) The necessity for avoiding the crystals falling out of suspension in the well—the prolific cause of the formation of rock salt at that point.

Period During which the Crystals Must Remain in Suspension

It is necessary to maintain the crystals in suspension in the saturator for about 1¼ to 1½ hr. before ejecting the magma to the centrifugal. In other words, starting with bath liquor of the correct composition, about 1¼ to 1½ hr. may elapse before the super-saturated solution containing the ammonium sulphate crystals is ejected to the centrifugal.

How Temperature and Free Sulphuric Acid Content can be Maintained Uniform

The temperature of the mother liquor in the bath depends on the rate at which by-product ammonia is introduced to the saturator. Provided always that a uniform feed of concentrated gas liquor is maintained, there should be no undue fluctuation in the temperature of the bath liquor.

Similarly, it is necessary to supply the sulphuric acid from a constant head tank through orifice disks, or through a suitable measuring device.

Effect of Temperature and Free Sulphuric Acid Content on Crystal Size

Fluctuations in the temperature and the free acid content of the bath liquor affect the solubility of ammonium sulphate. If a reduction of temperature occurs, deposition of ammonium sulphate results, or if the temperature increases, the ammonium sulphate crystals are re-dissolved. If crystals are to grow to a definite size, it is important that fluctuations of the latter order should be reduced to a minimum.

Moreover, the crystals must be given time to grow. It would be fatal to the formation and development of a good crystal for the sulphate magma to be ejected at too great a rate. This factor cannot be stressed too much. The men operating the saturator should have this consideration constantly before them.

The formation of large-sized crystals of sulphate of ammonia demands not only a saturator of correct dimensions, for a given throughput, suitably equipped, but conditions at the dissociator (still) should be constant. The feed of concentrated gas liquor to the dissociator, and its temperature, should be uniform, and the supply of steam must be constant and preferably recorded. In addition, there should be careful control by the Works Chemist of the acidity of the saturator and the weak solution of ammonia used as a neutralizing medium; he should also examine the final salt for (*a*) acidity or alkalinity, (*b*) colour, and (*c*) screen analysis.

The operation of centrifuging calls for equally careful control. Mother liquor should not be allowed to overflow from the monitor case to the shoot below, and contaminate the neutral sulphate of ammonia.

The time occupied by the several operations involved in the centrifuging of the acid-containing sulphate should be approximately as follows:

Filling the centrifugal basket and applying the water wash at the completion of the filling	2 min.
Centrifuging at full speed to discharge the acid mother liquor: then the weak ammonia solution for neutralization should be applied	2 „
Centrifuging at full speed	4 „
Discharge of the sulphate through the central valve	2 „
Total time occupied	10 min.

These times may vary slightly, according to the size of the centrifuge. The method of filling the basket is a matter of importance. Sulphate of ammonia builds up heavily, but the accumulation should be gradual, and it should be effected during the time that the basket is slowly rotating. As the depth of the salt bed increases in the basket, the remaining quantities of mother liquor are projected in the direction of the spindle, and move inwards and upwards, emerging at a point near the top of the basket, where the resistance of the salt bed is least. The permeability of the bed depends on the size and uniformity of the crystals of which it is composed. With a large crystal there is a greater ratio of crystal surface to crystal mass, and greater permeability.

It is remarkable that long periods of spinning have so little effect upon the acidity. Experiments have revealed that the centrifuge may function as an evaporator, eliminating water by evaporation, as distinct from the removal of water by filtration. Support is given to this view by the fact that the ratio of water to acid in the filtered salt is totally different from that in the mother liquor.

Neutralization of the acid-containing sulphate is effected by finally spraying with a predetermined quantity of weak ammonia solution. There is no need to use a stronger solution than 0·4 per cent. ammonia, provided the crystal structure of the salt is satisfactory, and the process of centrifuging is carried out efficiently. 8 gal. of neutralizing medium containing 0·4 per cent. ammonia are sufficient to neutralize completely 7½ to 8 cwt. of acid-containing salt. After leaving the centrifugals, the sulphate is dried in either a shower or shelf type of dryer, using air at 150° C. These drying towers are made almost wholly of wood, and indeed are the ones installed twenty years ago.

"Metro" sulphate is now made either exclusively from concentrated gas liquor, or from mixtures of concentrated gas liquor and gas liquor. Its quality has not altered materially since it was first made in 1919. It is of rather larger crystal size than that originally made. It is guaranteed to contain 25·71 per cent. of ammonia (21·14 per cent. nitrogen); it is neutral, the moisture content is invariably of the order of 0·04 per cent., and it is of good colour. It is made in many qualities—agricultural, industrial, battery, super-battery—and it can be ground to suit the requirements of those who are anxious to manufacture lawn sands.

The superphosphate industry has recently become impressed with the necessity for the production of granular superphosphate and compound fertilizers. After all, the possibility of applying any fertilizer in drills is very unsatisfactory with a mixture of fertilizer constituents consisting of powdery materials. Powders are usually dusty when dry, and sticky when damp, and crystalline or granular particles of appreciable size obviously flow more readily than powders.

The possibility of applying any fertilizer in drills is repre-

sented by its ability for uniform and regular distribution. It is doubtful whether there is much difference, from the point of view of storage and distribution, between a crystalline and a granular product. The international superphosphate industry has not yet decided whether granules ranging from 1 to 1·6 mm., or from 1·6 to 2·5 mm., are the better. It would seem that the smaller the size of a granule, the better, provided it stores satisfactorily, and can be distributed without loss.

By-product coke oven managers may find it cheaper to granulate any fine sulphate of ammonia they may produce in semi-direct plants, rather than attempt to circulate their bath liquor, or resort to methods for the treatment of any ferric iron as a complex ferri-oxalate by using oxalic acid. At all events, this is an aspect that might merit careful consideration, as granulation may well prove to be cheaper than chemical treatment.

PROCESSES FOR UTILIZING CONCENTRATED GAS LIQUOR IN THE MANUFACTURE OF OTHER FERTILIZERS

Knowledge of the efficiency of the application of fertilizers is a subject concerning which only limited information is available. Fertilizers containing ammoniacal as well as nitrate-nitrogen are certainly growing in favour in this country. Invariably these fertilizers are sold in granular form, and contain about half their weight of calcium carbonate. The latter may be advantageous in counteracting soil acidity, and the nitrate-nitrogen possesses the merit of being immediately available to the soil, and, unlike ammoniacal nitrogen, does not need nitrifying organisms to play a role before advantage can be taken of it by the soil.

It must not be imagined that synthetic ammonia works are more favourably placed than by-product ammonia factories for the manufacture of fertilizers containing nitrate-nitrogen. On the contrary, the production of crude liquor ammonia made from gas liquor in automatically-controlled plants, at a cost which is competitive with that of synthetic ammonia, has rendered possible the manufacture of a variety of fertilizer materials and mixtures containing nitrogen. The following table will perhaps afford a ready means of visualizing what the possibilities are in this direction:

TABLE 7.—*By-Product Fertilizers and Compounds Containing Nitrogen*

Plant Food Element.	Fertilizer.	
	Compounds.	Mixtures.
1	2	3
Nitrogen	Ammonium nitrate Calcium nitrate Sodium nitrate Urea Ammonium sulphate	Nitro-chalk
Nitrogen and phosphoric acid		Ammoniated sulphur-phosphate
	Mono-ammonium phosphate	Ammonphos
	Di-ammonium phosphate	Leunaphos
	Urea-phosphate	Phosphazote
		Ammoniated super-phosphate
Nitrogen and potash ..	Potassium nitrate	Potazote
		Kaliammonsalpeter (*i.e.*, potassium - ammonium nitrate)
Nitrogen, phosphoric acid and potash		Nitrophoska Ammophosko and other N.P.K. fertilizers

Obviously, within the limits of a Paper of this kind it is impossible to deal with the economics and manufacture of all the fertilizers mentioned in Table 7.

Given ammonia, sulphuric, nitric, and phosphoric acids (all of which can be suitably manufactured at a central chemical works), and potash salts, which can always be purchased to advantage, it will be appreciated that it is not a difficult matter to manufacture a wide range of N.P.K. materials, either as "compounds", or as chemical fertilizers.

Several years of active association with the calcium superphosphate industry has taught the Author that the most lucrative branch of the fertilizer industry is the compound manure, or chemical fertilizer, section. If a maximum revenue for by-product ammonia is to be obtained, it is certain that this branch of the fertilizer trade must be exploited by the central chemical works, which have been the subject of consideration in this Paper.

THE FUTURE

With the increasing availability of waste heat steam, all Gas Works should be in a position to manufacture concentrated gas liquor profitably. This should be sent to a centrally-situated chemical works, having the facilities already indicated. Such chemical works should manufacture those ammonium products which are calculated to ensure the highest revenue.

Where sulphate of ammonia is manufactured, the plant should be in units with a capacity of not less than 50 tons per day, using exhaust steam from pass-out turbines or back-pressure engines. In this way mechanized plants can be operated at a minimum of cost, from the point of view of labour and motive power, and the exhaust steam can with advantage be used for process work. Whether an attempt should be made to dispense with centrifuging, neutralizing and drying, on the lines of the Fauser reaction chamber, or whether the Escher-Wyss automatic discharge centrifuge, which is the nearest approach yet to a continuously-operating machine, should be used, is a matter for careful consideration. That fertilizer products can be manufactured profitably at such central chemical works is certain, having regard to the facility with which crude liquor ammonia can be manufactured in automatic plants, and equally profitably converted to nitric acid.

In view of the availability of surplus sulphur material in the form of spent oxide, phosphoric acid or calcium superphosphate, both of which involve the manufacture and use of sulphuric acid, should be produced, unless other arrangements can be made for the realization of the maximum market value of spent oxide.

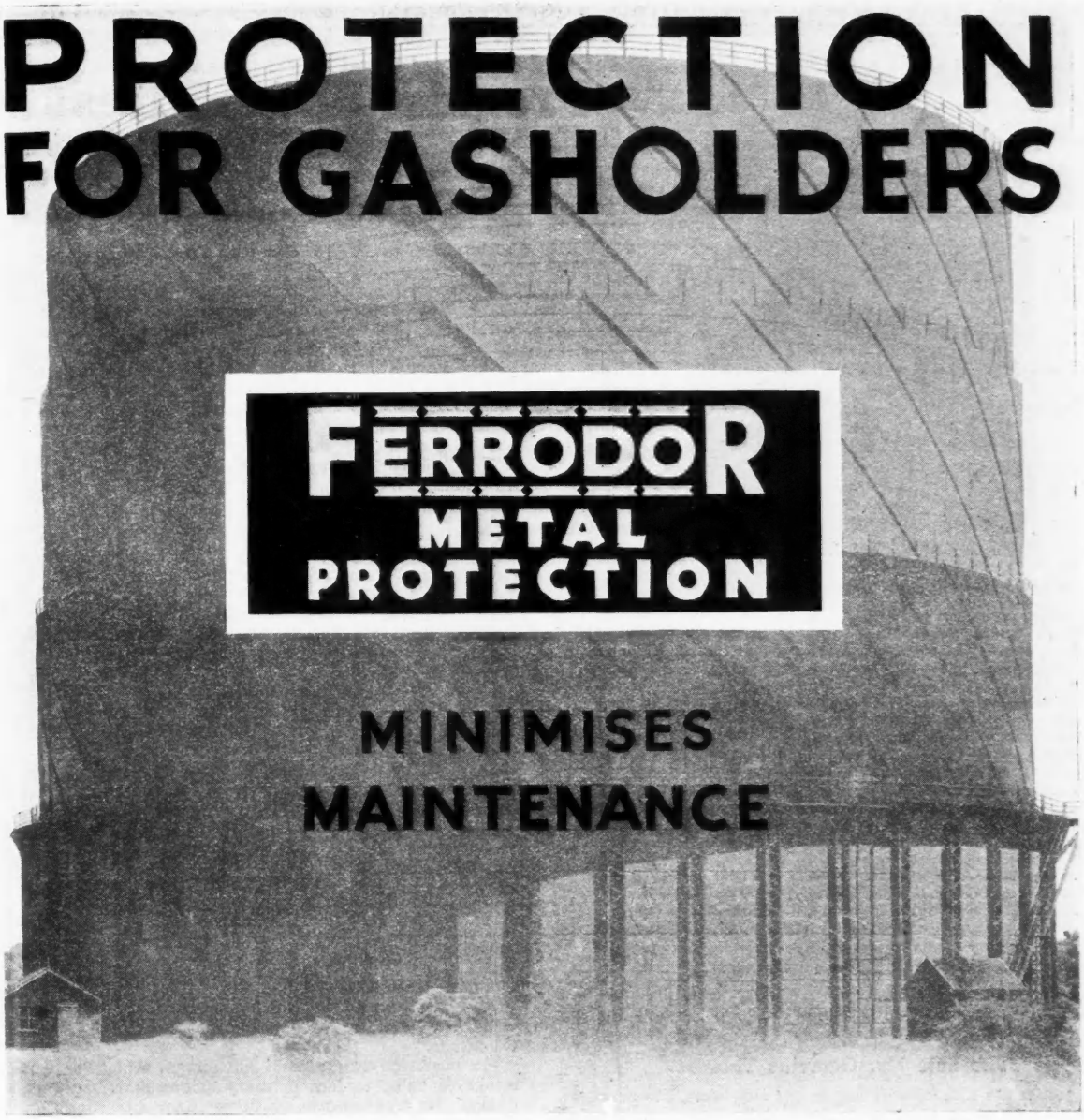
APPENDIX 5

COST SHEET

RELATING TO A PLANT HAVING A CAPACITY OF 4,000 TONS OF CONCENTRATED GAS LIQUOR, 20 PER CENT. AMMONIA BY WEIGHT, PER ANNUM

	£ s. d.
1. Steam for the distillation of the ammoniacal liquor in the production of concentrated gas liquor: Concentrated gas liquor .. 20 per cent. ammonia by weight Gas liquor .. 1·5 per cent. free ammonia by weight = 13·33 tons at 100 per cent. efficiency, or at 90 per cent. efficiency, which can be guaranteed. 13·9 tons of gas liquor to be distilled per ton of concentrated gas liquor, 20 per cent. NH_3 by weight. Steam consumption can be guaranteed at less than 18 per cent on such gas liquor. 18 per cent. on 13·9 tons = 2·52 tons of low-pressure steam, 15 lb. per sq. in., at 1s. per ton	2 6
2. Labour	—
3. Chemical Supervision	9
4. Cooling Water: 4,000 gal. per hr. required, or 96,000 gal. per day, assuming the temperature to be of the order of 18° C. If a Premier cooler is adopted, only 10 per cent. replenishment water will be required, *i.e.*, 9,600 gal. per day at 4d. per 1,000 gal., 38·4d. 13 tons per day	
5. Repairs and Maintenance	6
6. Depreciation (at 7½ per cent.) and Interest on Capital (at 5 per cent.) = 12½ per cent. on estimated cost of plant, and piled foundations (£5,600) = £700. Or $\frac{£700}{\text{4,000 tons of concentrated gas liquor per year}}$ ..	3 6
7. Overheads and contingent expenses, not included in the above items, say, ...	1 0
Total Manufacturing Cost, per Ton	8 6
Cost per Unit of Ammonia = $\frac{\text{8s. 6d. per ton}}{\text{20 units}}$ = 5d.	

PROTECTION FOR GASHOLDERS



GRIFFITHS

BROS. & CO. LONDON LIMITED
Paint, Enamel and Varnish Specialists
Macks Road, Bermondsey
LONDON, S.E.16

BERmondsey
1151

A·R·P PAINTS

"ARMOUR" CAMOUFLAGE PAINTS
"ARMOURGLO" LUMINOUS PAINT
"ARMOUR" WHITE KERB PAINT
"SHAYDOLITE" BLUE LAMP LACQUER
"ARMOUR" BLACK-OUT PAINT

WRITE FOR FURTHER PARTICULARS

WALES AND MONMOUTHSHIRE ASSOCIATION

THE PRESIDENT.

Eldest son of the late Mr. Thomas Canning, Mr. J. H. Canning, O.B.E., J.P., was educated at Prior Park College, Bath, and subsequently studied engineering and science at the Technical College, Newport, where he was particularly successful. He was Silver Medallist in Science in 1893 and Gold Medallist for the best record in Science over the three years 1892 to 1895. In 1897 he was awarded First Prize in the Honours Class and the National Silver Medal of the City and Guilds of London Institute. He was appointed Engineer and Manager of the Newport (Mon.) Gas Company in 1919 in succession to his father, a position he held until his retirement at the end of April, when he was elected to the Board of the Company. President of The Institution of Gas Engineers in 1932, Mr. Canning has twice before occupied the Presidential Chair of the Wales and Monmouthshire Association—in 1910 and 1920. In 1915 he was appointed by the High Explosives Committee to organize and direct the work of providing high explosives in Wales and Monmouthshire, being assisted by a committee of five Gas Engineers. He was appointed divisional officer (coke and gas) for the same area in 1918. He was made an Officer of the Order of the British Empire in 1920 for his war services. He has been Chairman of the South Wales District Committee of the Federation of Gas Employers and also of the South Wales Regional Gas Industrial Council.

Presidential Address

OF

J. H. CANNING, O.B.E., J.P.,

of Newport.

Given at the Annual Meeting of the Association held at Newport on May 25.

I thank you for the great honour you have done me in electing me your President.

The Late Mr. Octavius Thomas.

I feel that I should be failing in my duty were I to proceed with the technical portion of my Address without paying a tribute, however inadequate, to our first Honorary Secretary, the late Mr. Octavius Thomas, by whose lamented death this Association has sustained an inestimable loss. Mr. Thomas was an engineer of outstanding ability as is demonstrated by his able conduct for so many years of both gas and water undertakings supplying one of the largest and most difficult areas in the British Isles. On this occasion, however, we should recall with gratitude his long, able and self-sacrificing service to this Association and its individual members. As far back as March 1, 1905, he summoned the preliminary meeting at which it was decided to form the Association. He was, on the same day, elected its Honorary Secretary, and his faithful and diligent labours on its behalf ceased only with his life.

He was a man of untiring industry which he was always ready to place at the service of the high ideals by which his life was moulded and directed. First among these came his unaffected and devoted attachment to his Church from which he drew inspiration for the rest. Next in order came his duty to the undertakings he served and, after this, his wholehearted devotion to the interests of the Gas Industry and his unceasing endeavour to maintain the status of the gas engineering profession. The last letter signed by him was written in defence of this. One of his most striking characteristics was his sympathy with the young men entering our Industry irrespective of the grade to which they aspired. He realized that, in the interest both of the Industry and themselves, it was essential that they should receive the best possible training and he spared no pains to secure for them the necessary educational facilities and to encourage them to take full advantage of these. With this end in view he successfully urged upon this Association the scheme whereby prizes are awarded to the juniors for reading Papers, for success in examinations, and for action furthering the aims of the local Junior Association. This has certainly been productive of excellent results and is an example which, if followed more generally, would undoubtedly be to the advantage of our Industry.

In addition to his direct activities on behalf of this Association he voluntarily undertook important and exacting duties in connexion with the various activities of the Gas Industry in South Wales which were of untold advantage to its members and the undertakings they served. He carried out the secretarial duties to the Special Purposes Committee of this Association, the South Wales Tar Committee, the South Wales Education Committee, the South Wales Committee of the Federation of Gas Employers, and was Joint Honorary Secretary to the South Wales Regional Industrial Gas Council from its inception. It is almost incredible that one man, single-handed, should have filled so many important posts. He not only did so, but he carried out the duties in every case efficiently, unfailingly and with scrupulous exactitude.

He possessed two natural advantages which were of inestimable value to him in carrying out these multitudinous duties. He was endowed with an exact and comprehensive memory and he possessed a natural expertness in mental calculation which was almost uncanny. This district owes him a special debt of gratitude for his services in connexion with the Federation of Gas Employers. While scrupulously loyal to the interests of the employers he showed such an understanding of the case for the workers and was always so scrupulously fair that he commanded the respect and esteem of both sides of the Regional Council, and it is largely due to his influence that the relations between the employers and employed of this district are marked by reason and restraint. He was ever quiet and unassuming, but when a matter of principle was involved he could exhibit a tranquil firmness which must often have surprised those who were not intimate with him. He was generous, great-hearted, and ever ready to extend practical help as well as sympathy to all who were worthy of it. He was one of the most lovable of men, an ever loyal and faithful friend, and none is more worthy than he of the tribute paid by Shakespeare's Antony to Brutus:

> " His life was gentle; and the elements
> So mix'd in him, that Nature might stand up
> And say to all the world, ' This was a man! ' "

If we ever permit ourselves to allow his memory to fade

from among us we shall be unworthy of his long and self-sacrificing labours on our behalf.

Coke Oven Gas Supply to Newport.

The Newport (Mon.) Gas Company began to supply coke oven gas to its consumers in December, 1937. The supply is taken from the coke ovens of British Benzol and Coal Distillation, Ltd., at Bedwas, consisting of a battery of thirty-five Becker regenerative ovens having a throughput of some 700 tons of coal per day. The gas is conveyed to Newport through a 12 in. pipeline laid along the main Caerphilly-Newport road as far as Bassaleg, whence the main proceeds by way of Glasllwch Lane over Barrack Hill to the Crindau Works.

The total length of this route is 18,121 yd., or approximately 10·3 miles. A cast iron main was decided upon and after careful consideration the Stanton-Wilson joint was adopted. With the exception of short sections where it was necessary to negotiate curves, 18 ft. lengths of pipe were employed. On the curves 12 ft. and 9 ft. lengths were used, where required, in order to give greater flexibility. Of the total length of main 3·4% was laid in 12 ft. lengths and 2·0% in 9 ft. lengths. At certain points on the line of main sharper bends, including one hairpin bend, were encountered and it was possible to negotiate these in almost every instance by carrying the main in a wide sweep with easy bends. As a precaution all bends were backed with concrete.

The main was laid by a contractor and the time for completion was 26 weeks. The pipeline was actually completed in 23 weeks. The work was started with one gang only but operations were started progressively at various points so that, eventually, five separate and independent gangs were at work at different points. Two bridges over railways occurred on the route over which the main could not be laid on account of insufficient cover. One of these was a skew masonry bridge, the builders of which had continued the arch work outside the parapet on one side. This afforded a convenient platform for the laying of a main with Stanton-Wilson joints. In the case of the other bridge which was constructed of steel girders, the railway was crossed by means of a section of welded steel tubing 71 ft. 6 in. in length supported from the bridge girders.

The specified depth of cover was 3 ft. This was exceeded at various points either in order to avoid underground obstacles or to make allowance for prospective lowering of road levels connected with highway improvement. It may here be remarked that in a period like the present when our roads are in a state of transition, it is very difficult indeed to make due and proper allowance for future alterations in road level. A tribute is due to the local road authorities who did all that lay in their power to assist in this matter. They were, however, able to afford only limited information, as the plans of the Ministry of Transport in respect of these roads had not been completed. The average depth of cover on the completed main is 3 ft. 1·055 in., being 2·93% in excess of the specified cover.

The main was tested with air at a pressure of 50 lb. per sq.in. in suitable lengths with the joints exposed. In all, 138 tests were made which gives an average length of 131 yd. per section tested. On the completion of the pipeline the whole length was put under test and the full test pressure of 50 lb. per sq.in. was maintained satisfactorily for 48 hr.

Considerable difficulty was experienced at the commencement in the matter of testing the joints for tightness owing to the fact that the "soapsuds" test which is so satisfactory in the case of other forms of joint is inapplicable to the Stanton-Wilson joint. This difficulty was successfully overcome by a member of my staff, Mr. C. B. Felton, who superintended the work. He devised a rubber bag, by means of which a joint can be completely submerged in water, when the slightest leakage is at once indicated by the rising of bubbles to the surface. This test is most delicate and there can be no doubt but that its use on this line of main was instrumental in securing its absolute tightness under pressure. Since the completion of the main from Bedwas no less than 32,641 yd., equivalent to 18·54 miles, of 6 in. cast iron main with Stanton-Wilson joints have been laid for a high-pressure supply of coke oven gas to Chepstow and Caldicot. The "Felton" tester was used upon each of the 5,756 joints in this pipeline with the result that the entire length of main, when completed, successfully withstood an air pressure of 50 lb. per sq.in. for a period of 53½ hr.

The gas, after the extraction of ammonia and benzole in the by-product plant, passes through a naphthalene washer to the inlet of a Holmes-Connersville meter which records the volume of gas purchased. The compressing plant, which follows the meter, consists of two Holmes-Connersville boosters each driven by a Reader double crank steam engine. The gas is at present delivered at Newport in the unpurified state and the pressure is governed down before its admission to the inlet of the purifiers. After purification, the volume of the gas is measured before its admission to the holders.

Analyses of the gas show that its composition is as follows:

CO_2	2·0% to 2·3%
O_2	0·0 „ to 0·2 „
C_nH_m	2·0 „ to 2·1 „
CO	5·6 „ to 6·1 „
CH_4	25·0 „ to 26·6 „
H_2	56·4 „ to 58·0 „
N_2	5·1 „ to 7·0 „

The calorific value is slightly above the declared standard of 500 B.Th.U. per cu.ft. The specific gravity is between 0·36 and 0·37 and the sulphur compounds do not exceed 4 grains per 100 cu.ft.

In view of the possibility of an interruption of the supply of coke oven gas due either to strikes in the coalfield or any other cause, a stand-by plant has been installed at the Crindau Works. The plant selected for this purpose is the Jones oil gas plant which has been very successfully operated in the United States for a number of years past. This plant has already been described in a Paper recently presented to the Institute of Fuel. The principal reasons for the selection of this plant are as follows:

(1) The gas produced approximates very closely in composition to ordinary coal gas and obviates, to a great extent, the adjustment of burners and apparatus.
(2) It is capable of being put into operation at very short notice.
(3) It can be worked with a minimum of labour.
(4) It dispenses entirely with the use of solid fuel as even the boilers are heated by oil fuel. This is a very important point in the event of a coal strike.
(5) Its low capital cost, as it is only necessary to provide housing and protection for the moving machinery. A building was available at Newport and this was made use of.
(6) The small ground area required.
(7) The plant can, if necessary, be operated without a relief holder or exhausters. These were both available at Newport and were, therefore, made use of, but they are not necessary.

You will have an opportunity of seeing both the coke ovens and the Jones oil gas plant this afternoon, and it is hoped that these few introductory remarks may make your visit more interesting.

It may be said in conclusion that, in spite of the very large expenditure involved, it has been possible since the introduction of coke oven gas to make a general reduction in the price of gas to consumers and also to offer domestic consumers a two-part tariff by means of which, after the payment of a small fixed quarterly charge, the consumer obtains gas at half-price. In addition to this, special scales and contracts have been provided for in the case of industrial loads, and it is hoped that these steps will have the effect of promoting the sale of gas to the advantage both of the consumer and the Company.

Wear and Tear Allowances

Plant and Machinery

A revised schedule of agreed rates of depreciation for the purpose of computing liability to United Kingdom income tax, containing certain amendments and additions to the earlier list, has recently been issued by the Board of Inland Revenue. The revised schedule in full has been published by the Association of International Accountants (with the sanction of the Board of Inland Revenue) and issued as a supplement to the May edition of the *International Accountants' Journal*. A limited number of copies of the Journal containing the supplement are available at the price of 7d. post free, at Planet House, 12a, Finsbury Square, London, E.C. 2.

Management of Gas Undertakings

by

G. M. GILL, M.Inst.Mech.E., M.Inst.Gas E.

Consulting Engineer, Director, and Chief Engineer of Severn Valley Gas Corporation, Ltd., and Gas Consolidation, Ltd.

A Paper to the Wales and Monmouthshire Association of Gas Engineers and Managers at their Annual General Meeting on May 25

The title of this Paper covers so wide a scope that it is difficult to know what to include and what to omit. Accordingly, the Author proposes to confine himself to the making of suggestions which are based to a large extent upon experience in Holding Company work.

Obviously a Holding Company would like to see all its Subsidiary Companies well managed and showing steady progress. It is quite clear that in these competitive days progress cannot be attained without steady and persistent effort on the part of the Management.

It is very noticeable that gas undertakings which have been under good management for many years are in a very different position to those where the reverse has been the case. It takes many years for the best of managers to counteract the evils of bad management. Those who have had this problem to face should not be discouraged, but should look upon the task as one calling for high qualities, and one worthy therefore of a high-class man.

In contributing this Paper the Author is endeavouring to outline certain principles which if observed will go a long way, he submits, towards ensuring that the undertaking in question will be well managed.

Each Man His Own Job.

In some works it will be found that the Manager has carefully arranged, preferably in writing, for each man to have clearly defined duties. Where this principle is adopted the men are undoubtedly more interested in their work and more likely to carry out their duties satisfactorily than in Works where a man's duties are constantly changed from day to day. A man will take an interest in doing one job or certain fixed duties for which everyone knows he is responsible, even if it is only the sweeping up of the yard. Accordingly, this principle is advocated as one which it is thought can be adopted everywhere with advantage.

The Author has for a long time past thought that the proper method of keeping plant in good order is for the Manager to have an Inspection Book in which are clearly set out the periods when each part of the plant is to be systematically inspected and by whom the inspection is to be made. Provision is made for entering in the book the date, result, and signature of the man who makes the inspection. With such a system it is arranged beforehand how often the inspection is to be made and therefore such inspections become systematic which is far superior to haphazard inspections which leave too much to chance.

A Stitch in Time . . .

It is undoubtedly a fact that the cost of repairs and maintenance and the certainty with which plant will function when put to a test such as at peak load times are both favourably influenced where the management adopts the policy of attending to defects directly these are disclosed. There is nothing worse than the type of management which attends to nothing until breakdowns occur. In most cases breakdowns are due to bad management. Nearly all can be avoided by adopting the policy set out above.

It is frequently noticeable that in some works there are no easy means of access to many parts of the plant requiring regular inspection. As a result these inspections are very apt to be neglected. When the Author first took charge of a works he fitted staircases to numerous parts of the plant, so making it easy for everyone concerned to carry out inspections. Where there were no facilities for staircases, ladders were fitted of a type which were easy to climb. This is undoubtedly a wise policy.

Having been closely concerned on a large scale with gasholder inspections, he has observed that the neglect of lubrication of gasholders has been frequent in cases where ladders and hand-railing have not been provided. One cannot complain of men being unwilling to undertake a risk in doing work of this kind. A workman is not likely to complain that he is unwilling to attend to the greasing of a holder because it is not safe. He is more likely not to do it at all.

The proper policy is for the management to make it safe and then there is no excuse. The operation of the Factories Act, 1937, has shown that there are some hundreds of gasholders which cannot be lubricated in safety and this explains to a large extent the neglect which has been discovered in numerous cases.

Accordingly, it is important always to provide safe access to all parts of plant requiring periodical inspection.

The Cost of Repairs and Maintenance.

This item is a very heavy one, both in works and on the district, but it can be minimized to a material extent by carrying out the above principles, although, of course, there are a number of other important factors. Nowadays, many new materials have been developed and are available to assist in the reduction of this item. For instance, the use of reinforced concrete instead of steel, bricks, or timber; the use of asbestos cement instead of iron, steel, and timber for a number of purposes; the use of better paints and coatings to resist corrosion. Many other instances will readily occur to engineers.

The repairs and maintenance item can so easily be a snare and a delusion. If it is high it does not always follow that wastage is being properly made good. There is sometimes much extravagance under this heading and much also which is not correctly described as repairs and maintenance. Again, when the cost of this item is low there may still have been an adequate replacement of wastage due to the care taken in the original design and construction of the plant and to the efficiency with which it is kept in repair. The saying "A stitch in time saves nine" applies most aptly to the care of engineering plant, and its application can save a great deal of money.

Accordingly, it is important that an engineer in designing or ordering plant should never overlook the question of the future cost of repairs and maintenance of such plant. Frequently, such changes can be made in the design as will reduce these costs in the future.

Efficiency of Gas Production.

It is frequently stated in certain sections of the Technical Press that the production side of the Gas Industry is highly efficient and that if the same efficiency could be reproduced on the district there would be an all-round benefit.

Having had an exceptional opportunity of inspecting a very large number of gas-works in this country during the past few years, the Author does not share that view. On the contrary, he thinks there is much scope for improvement.

Indeed, he has found in numerous cases that the only practical way of obtaining sufficient revenue to enable district arrangements to be modernized and new tariffs introduced has been to improve works' results and so make cheaper gas and then to spend the money so saved on the district.

He suggests, therefore, that it is a dangerous doctrine to be too easily satisfied with works' results,

Quality of Gas.

It is the Author's belief that there is nothing more important than the supply of a gas of good and uniform quality. Whatever the declared calorific value, that, of course, should be maintained as an average and within a minimum of variation both in calorific value and specific gravity.

As regards other characteristics the oxygen content should not, in his opinion, exceed 0·5%, which after all is equivalent to 2½% of air. This is not difficult to attain in practice, and where the gas is not dried then it is particularly important to keep the air percentage at a low figure, so rendering the gas as non-corrosive as possible. There is no doubt that the supply of a gas of good and steady quality has an important bearing on the prosperity of a gas undertaking, although it may take quite a long time to have its effect.

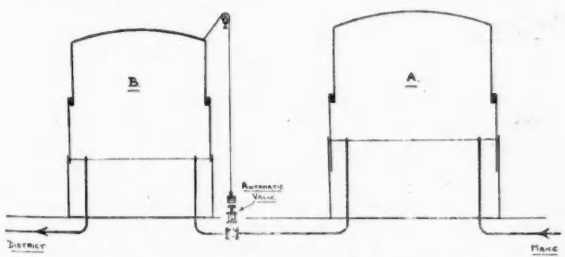
On the other hand, the supply of gas of varying quality makes it impossible, in the Author's view, for a gas undertaking to be prosperous. In any business the quality of the product, whatever the product may be, must be a factor of the greatest importance. In the case of all commodities it is an undoubted fact that the public will never for long continue to buy any product of which the quality is poor or varying. It is the same with gas. Accordingly, it is impossible to stress too much the importance of an adequate supply of good quality gas. Certainly, this is one of the most important duties of a manager.

While tempted to deal with the methods of maintaining the quality of gas, space will not permit of this. Attention might, however, be called to the importance of retort house work. The Author has noticed only too often the obvious unpopularity of the retort house in the eyes of some managements. Where this is the case it is a great pity and is responsible for much which is detrimental to the prosperity of a gas undertaking. The retort house is a most important place and should never be omitted by the manager in his daily round of inspection. This question of gas quality is largely dependent upon the way the work is done in the retort house.

Use of Two Holders

There is, however, one matter which, apart from the retort house, materially assists in maintaining a uniform quality, and that is to arrange that the gas as made passes through two holders before being supplied to the district.

He has found that in many cases this method is practicable without any material alteration to mains and valves, but even where such alteration is necessary it is very advantageous to bring about these conditions.



All the make gas passes first into A and then into B. Holder A must throw more pressure—½ in. or less is sufficient—than Holder B, and if both holders have two lifts, as in the sketch, then both lifts of Holder A must be heavier than those of Holder B. If necessary, Holder A can usually be weighted sufficiently for this purpose. The automatic valve on the inlet to Holder B closes when Holder B is full and opens as the holder lowers.

Above is shown diagrammatically a method of doing this, and as will be seen it can be followed in many cases. The Author first saw this arrangement some years ago at the Clevedon Works when Mr. Pye, the Manager, told him that no holder valve had been touched for 18 years and that all gas supplied to the district passed through two holders. Since then it has been adopted at a number of works with which the Author is concerned and in all cases the result in the uniform character of the calorific value of the gas has been very marked.

Set out below are the summarized readings of the recording calorimeter showing the gas supplied from the Works of the Wem Gas Company which makes 12 million cu.ft. per annum and operates its two holders in the way described above.

As will be seen the result is remarkably satisfactory, bearing in mind also that the gas was being made during the whole of the month of March, 1939, in one setting of 6 single-ended horizontal retorts.

Calorific Value Results for Month of March, 1939, at Wem Gas-Works.

Maximum calorific value	536 B.Th.U.	
Minimum " "	487 "	
Average " "	504 "	
Maximum variation over month	49 "	= 9·8%
Average daily variation	3·4%	

Coke.

Experience shows that the policy pursued in regard to coke by some undertakings leaves room for a good deal of improvement. Experience goes to show that those who use a good class of coal and accordingly obtain a coke reasonably low in ash, while at the same time supplying coke of the requisite sizes, have little trouble, given ordinary energy, in selling their entire production at fair prices. It is undoubtedly essential that to meet the local demand for coke and to keep out imported coke, graded sizes must be supplied by the local undertaking and further stocks must be available at all times. It is a fact that in numerous gas-works no provision is made for grading coke. Obviously, no householder can use coke of the size as made in the retort house and, therefore, graded sizes are an absolute necessity. As a result of failure to provide suitable sizes coke is imported, and this starts competition of which managers frequently complain. The demand for unbroken coke is limited to those, mostly large users, with furnaces of a type which can use large coke efficiently. These are industrial and commercial users, but there is a limit to the demand to be expected from this quarter, and, therefore, it is clear that all gas-works should have some means of grading coke into two or more sizes, in addition to breeze.

Maintaining Coke Stock.

As regards stocks of coke it is a fact that many managers will run out of stock without any qualms, and consider that it is a cause for congratulation, though if they kept a shop they would know that it was fatal to run out of stock of what their customers require. Such action on their part would merely send their customers to a competitor, and that must happen in the case of coke. Accordingly, it is important to maintain a minimum stock of some predetermined amount and whenever the stock is reduced below this figure efforts should be made to buy coke from a neighbour, and this is usually possible. It is then not a question of making a profit which is of importance but rather the maintenance of the coke business and customers' goodwill.

Reference has already been made to the importance of the quality of the coke, and in this connexion the quality of the coal used is obviously of paramount importance.

The Author is indeed gradually becoming convinced that there is little scope, if any, for the use, however low in price, of poor quality coals in gas-works, as whatever the ash percentage in the coal used, the coke produced from such coal will have a higher content by 50%, and therefore if the coal is high in ash the coke may readily be unsaleable. The placing on the market of coke with, say, 15 to 20% of ash is going a long way towards killing the trade, in which case no coal, however, cheap per ton, can be considered to be worth buying. Fortunately there are large quantities of good coals in this country with low percentages of ash and there is no reason, except possibly in certain limited areas, for coal with a high ash content to be bought for gas-works' use. It is very advisable not to be complacent in this question of coal quality. Every time a manager complains of dirty coal, or refuses to take delivery of such coal, the day is getting nearer when all coals will be properly cleaned.

Importance of Coke Associations.

All good managers will wish to join District Coke Associations as these are undoubtedly an effective means of dealing in a proper way with the coke trade. Good work done by

the London and Counties Coke Association over many years has shown without question that similar work should be done in all parts of the country.

The Midland Counties Coke Association which is now in full swing is starting to do good work and there is no doubt that similar steps should be taken in all districts to introduce a true co-operative spirit, not only among producers of gas coke, but also of oven coke.

The settlement of the pressures to maintain at the Works is undoubtedly an important matter which will certainly not be neglected by a good manager. Such pressures can only be determined satisfactorily by the use of recording pressure gauges at various points on the district to compare with similar recording gauges at the Works. To do the work properly it necessitates the use of a number of such recorders. This is simple enough for large undertakings but it is a different matter for those small in size. A considerable number of pressure recorders are owned by the Holding Companies with which the Author is concerned and these are lent to any company which requires them, so saving what would be a heavy cost for a small undertaking to meet. It is not an exaggeration to say that the overhaul of pressures can result in a good increase in sales in cases where the pressures maintained have not before been satisfactory.

Mains and Services.

What has already been said earlier in this Paper applies particularly to those parts of the plant which are buried underground. No pains should be spared when laying mains and services. Infinite trouble results from neglect in this quarter. Regular inspection and by the right man is imperative. Some managers have been very conscientious and have quite rightly felt it incumbent upon them to make frequent and regular inspections of all such work while in progress. As is always the result in such cases those engaged on this work have become imbued with the manager's keenness with material benefit to the undertaking in question. The large leakage accounts of so many undertakings is an awful reflection on their past management.

Managers should deal actively with this problem and not adopt the line of least resistance by endeavouring to persuade themselves that it is not really leakage but is due to condensation, changes in temperature and pressure, and so on. Such considerations do account for some portion of the loss but a small portion only in the numerous cases which have come to the Author's notice.

Meters.

One cannot examine the inside of a meter without being impressed with the flimsy character of the internal construction.

Taking into account the fact that the meter is not lubricated in any way, and also that the gas as made nowadays has been freed to a large extent of any lubricating qualities which it formerly possessed, it will be realized that the meter has a bad time. Periodically it has to work at a very high speed well above its normal capacity, while at other times it is expected to measure the small quantity of gas used by a by-pass.

No wonder that meters go wrong and give dissatisfaction, as there is so much to cause trouble. The gas itself is not infrequently of a composition which is likely to give trouble in a meter. There may be gum present and small quantities of rust carried in suspension with the gas. Where gas is not dried there is a combination of moisture and oxygen present. As a combination in excess these render the gas corrosive and do much damage to meters. Gas also contains carbon dioxide, hydrocyanic acid, and sulphur compounds, all of which in the presence of moisture makes the gas corrosive and damaging to meters. Worse still, some gas contains a small amount of sulphuretted hydrogen and ammonium compounds. These are evil constituents which are very harmful to gas meters.

Taking everything into account, it is surprising that meters give as good service as they do, but nevertheless gas undertakings should give meters more attention than is normally the case.

All meters should be brought back into the shop at periodical intervals and the Author would suggest that no meter should be in use without shop examination for a longer period than, say, nine years, and further that every meter should be tested *in situ* periodically at intervals of three years. Every meter would then come under observation three times in nine years.

Most undertakings except those quite small in size should have some facilities for carrying out simple tests on meters in the shop. In many cases meters do not receive attention until some serious defect is disclosed, or in other words, until a breakdown occurs.

Continuous Meter Reading and Slot Collection.

It has been the custom in a large majority of gas undertakings to make quarterly meter readings and slot collections. This practice has necessitated considerable activity during certain periods of the year, and has in many cases resulted in fitters being taken off their usual work and put on meter reading or slot collection. It is thought that this is not a good practice and that it would be an advantage to all concerned if this system made way for continuous meter reading and slot collection. By such means there would be a steady continuity of work with no rush periods and everything could then be dealt with systematically and without disorganizing staff arrangements.

From the consumers' standpoint there would be no disadvantage in this arrangement. It needs a certain amount of trouble to initiate this system, but where it has been done it has been considered to be of real advantage to all concerned.

It is suggested that every manager should give consideration to this matter and should not dismiss the idea merely because of the difficulties during its initiation.

Maintenance on the District.

There is nothing more important if the goodwill of the public is to be gained and retained than the efficient maintenance of their gas-using appliances. Thousands of friends must have been lost to the Gas Industry and tens of thousands of lighting burners and the consumption of numerous appliances by the lack of a good maintenance scheme.

Maintenance schemes are expensive, but they are undoubtedly indispensable. One of the main reasons for the extensive loss of gas lighting has clearly been due to the want of adequate maintenance on the part of gas undertakings. It is quite hopeless to expect consumers to do their own maintenance. Not one in a hundred can or will do it adequately.

It is generally recognized that gas appliances get into an unsatisfactory condition in the course of time and it therefore follows that such appliances must be maintained. It is suggested that there is need to face up to the situation and adopt it as a general policy.

Fortunately, the provision of adequate maintenance of all domestic appliances need not be a great drain on an undertaking, as the scheme can be combined with the sale of additional appliances and with the carrying out of other necessary work such as the testing of meters *in situ*. It can also be combined with the making of a census of appliances, which after all is the basis of all sales propaganda. A little ingenuity in applying the maintenance scheme will enable two or more birds to be killed with one stone, and in the long run it will be found in many cases that such a scheme is self-supporting.

Service and Goodwill.

Service to consumers and obtaining their goodwill are undoubtedly closely allied to the question of maintenance. If consumers' appliances are kept in an efficient condition an undertaking is then half-way to obtaining their goodwill. Goodwill is an asset, the value of which is inestimable in the running of any business. It is suggested that if an undertaking first provides efficient maintenance and gives the good service which it will be agreed is necessary, then there will be bred the goodwill from which a successful business will be built up.

It needs, of course, some courage to look at the price of gas and the revenue profit and then to take one's courage in

both hands and start to spend money in providing maintenance and giving good service to consumers. Observation, however, shows that those who have adopted this practice have built up a business which is prosperous even in bad times, and has resources which enables it to meet heavy coal bills and to withstand without embarrassment the reduced sales resulting from trade depressions.

Selling Gas.

Some have thought that if sufficient activity were given to selling new appliances there would inevitably be increases in the sales of gas. Experience, however, shows that this is not necessarily the case and many must be disappointed with the results of their enterprise and energy in pushing the sales of appliances. The Author has found during the past few years that the companies which were most active and most successful in selling new appliances were just as likely to be reporting decreases in the sales of gas as those which had been more or less inactive in that direction.

It is true that most of these sales of appliances have been on the deferred system and it has been suggested that people with limited incomes could not both buy the appliances and at the same time the gas to be used in them.

Another explanation often used and true enough is that the substitution of a modern for an obsolete appliance leads to a considerable reduction in the amount of gas used under like conditions. Whatever the cause a good deal of disappointment has resulted from the small consumption in the houses of consumers which are modernizing their gas supply installations. However, in the long run, activity of this kind will surely have its effect, and as a result of energy in getting consumers' houses fitted up with modern appliances, which in the course of time will become their own property, there will eventually be an adequate reward.

Experience has shown that it is by no means difficult to effect large sales of modern appliances, even in the poorer districts, which is an indication that gas is looked upon as a desirable commodity for use in the future.

Selling gas is undoubtedly closely linked up with the subjects of maintenance, service, and goodwill, to which reference is made above.

Saturation.

The Author has often been told that a certain district is virtually saturated, but he has never found that there is any good reason for such a statement.

He doubts whether any district in the country, however progressive and successful the gas undertaking has been, is even approaching saturation. Saturation suggests a 100% of modern gas appliances of various types on each consumer's premises. Even with cookers it is not correct to claim saturation because all houses are fitted with cookers, of which 70 or 80% or more are black. Every house fitted with a black cooker is vulnerable to the wiles of the electricity salesman. As Mr. R. J. Rogers stated recently, "There is no electric black cooker."

In considering saturation we should only include the percentage of modern appliances and rule out those which are clearly out-of-date, the presence of which in a house must be suggestive of the need of replacement.

A good many think that a flat rate as the sole means of charging for gas is or should be dead. It is true that the flat rate must remain the basis for buying small quantities of gas and for settling the rate of dividend which can be paid under the sliding scale system and also as the basis for formulating a block rate and a two-part tariff scheme.

The Author holds the view that all gas undertakings should have a tariff system which can be said to fulfil all the requirements of domestic, commercial, and industrial consumers. Our electrical friends have almost invariably introduced a complete system of tariffs, so rendering it easy for customers to select a basis of charge which appears to be attractive, or, at least, reasonable, to them. It is suggested that the Gas Industry should do likewise as with the aid of suitable tariffs it is clearly possible to clinch business which otherwise would be unobtainable.

Certainly in these days an undertaking should have a block rate system and a two-part tariff scheme in operation. A block rate system if well devised provides the incentive to a consumer to use more gas. To give a customer an incentive to buy is an essential part of business life. On the other hand, a flat rate system whereby good and bad consumers alike pay the same price for gas must always be an irritant to a good consumer.

In formulating a block rate for the first time one can only make it attractive if there is sufficient spare revenue to permit of good reductions in the lower blocks. Otherwise the only alternative is to raise the top block, so providing for increased revenue from all consumers for some part at least of the gas they use. The money thereby gained can then be used to render the lower blocks attractive to the larger consumers. It may indeed take time by making adjustments when profits are sufficient to render the block rate system attractive to a large body of consumers.

Two-Part Tariff System.

Numerous managers have given consideration to the adoption of a two-part tariff system, but few have had the courage to adopt it. In these days of rising prices one can readily appreciate their feelings of doubt respecting the wisdom of introducing a method of charge which may result in a substantial reduction in their revenue. Theoretically the two-part tariff system should always result in an initial reduction in revenue and often a substantial reduction. Obviously, the best time to institute these systems is during prosperous periods when there is money to spare.

However, experience seems to show that the feared revenue losses from the introduction of this system are not realized in practice. The gains in consumption from those adopting the system appear to counteract fairly well the losses from the good consumers who adopt the system and then use no more gas. These latter consumers make, as is not unreasonable, a good monetary saving, and will probably in the long run use more gas. Experience shows that quite a section of consumers who used little gas when they were charged a flat rate become good consumers when they join the two-part tariff system.

Space will not permit of a long discussion on this subject but there is a good deal to be said for fixing the commodity charge at half-price, this being well understood by consumers.

The basis of the fixed charge is a more difficult matter and should obviously bear close relationship to the fixed charges of the particular undertaking. Generally speaking, if there is no good reason to the contrary, a good argument can be put forward for adopting the same basis of fixed charge as the local electrical undertaking. When this method is adopted it is more easily understood by the consumers.

In the case of commercial and industrial consumers it would seem that the best method to adopt is to judge each case on its merits, although obviously the general block rate adopted should be applicable to all such consumers. Even so there will undoubtedly be a number of cases which call for special consideration.

Budgeting.

In the Holding Companies with which the Author is concerned a system has recently been introduced whereby all companies prepare a budget during the early part of each year for the current year's working. This is prepared immediately after the balance-sheet of the previous year has been completed and while all the figures are in the mind of the management. Estimates for the current year are then made and the budget prepared. It is considered that this is something which it will be to the advantage of all undertakings to adopt.

It is hoped that the suggestions made in this Paper may prove of some use to those who are constantly confronted with the making of decisions and of recommendations to Directors and Committees.

(A report of the discussion which followed Mr. Gill's Paper will be published in a forthcoming issue of the "JOURNAL.")

EASTERN COUNTIES GAS MANAGERS' ASSOCIATION

Presidential Address

OF

J. KENNINGTON, D.S.O., M.C.

Engineer and Manager of the Great Grimsby Gas Company.

Given at the Spring General Meeting of the Association held at Grimsby on May 25.

THE PRESIDENT.

Mr. J. Kennington, who is holder of City and Guilds Honours Certificates in Gas Engineering and Gas Supply, was in the service of the Great Grimsby Gas Company under Mr. J. Terrace before the war. He mobilized with the Territorials in August, 1914, and served on the Western Front for nearly 3½ years. The recipient of two immediate awards for bravery in action, the D.S.O. and M.C., he finished with the rank of Lieut.-Colonel. Mr. Kennington returned to Grimsby, and has been Engineer and Manager of the Company since 1929.

Will you first allow me to express sincere thanks and appreciation for the honour you have conferred upon me, and the indirect compliment you pay to my Company, in appointing me as your President. I took the office in the sure and certain knowledge of your support, and I will, as far as my power lies, endeavour to maintain the high standard attained by past Presidents.

It is said that a specialist is one who knows more and more about less and less. The duties of a manager of a medium-sized gas-works are so multitudinous that he has not time to specialize. My Address, therefore, will be somewhat of a random nature, embracing general observations on matters of interest to our Industry, and an account of some of our activities at Grimsby during the past ten years.

Board of Trade Returns show that the sale of gas is steadily increasing year by year. It is an astonishing thing, but the general public do not seem to be aware of the fact. Gas has both cheapness and reliability in its favour, and every effort should be made, by giving efficient service and by independent and co-ordinated advertising, to maintain and increase its use and prestige.

A number of gas undertakings are taking a supply of coke-oven gas, and the time may not be far distant when nearly all collieries will be making gas, also fuel oil, petrol, coke, and other by-products, and it is reasonable to assume that only the purifying and distributing will be carried out by the gas undertakings. There is a limit, however, to the economic radius of Gas Grids, and only communities and industrie within reasonable distance of pit-heads can hope to derive benefit from such a supply. Taking the narrow view, Gas Grids and pit-head generation of coal gas are not going to improve the prospects of young men entering our profession

There will be fewer openings on the engineering (production) side, although there will still be ample scope for distribution engineers and salesmen. Gas undertakings not in a position to take advantage of a coke-oven supply of gas have sometimes, in their efforts to secure industrial loads, to meet competition which is somewhat unfair, the prices charged for gas for industrial purposes in coke-oven supply areas being quoted for them to meet.

Gas Making.

The manner in which we have been working our carbonizing plant for the past few years is, I think, unusual at a works of our size, and it may be of interest to you to hear how it came about that we have been working a continuous vertical retort plant in conjunction with our horizontal retorts.

During the winter of 1930-31 a steadily increasing demand for gas practically absorbed the maximum output of our existing carbonizing plant. For some years gas had been made in two horizontal retort houses, about 250 yd. distant from each other. No. 1 House, with six beds of through retorts, with semi-regenerators, had reached the point when it required to be renewed, or replaced by a more modern plant. Supervision was difficult, and maintenance charges heavy, because charging and discharging machines, and coal and coke handling plants had to be maintained in each house. It was obvious that great economy could be effected if gas-making could be carried out on one site, and that No. 2 House was more suitable and adaptable for purposes of extension.

With this end in view, I had prepared a preliminary scheme embodying four more beds of horizontal retorts to be added to the end of the existing bench. There was just sufficient room between the end of the retort house and our boundary wall to enable the requisite size of plant to be accommodated, and when the drawing was completed, everything seemed to have been worked out satisfactorily. After a further study of the scheme, however, it appeared to me to have one serious defect, and the more I thought about it, the more convinced I became that the scheme we had set down on the drawing board was not the solution to our problems.

Running through the works, and dividing it into two separate sections, is a public footpath, on either side of which are boundary walls. With the lay-out we had prepared, the new gable end of the retort house came within a few feet of one of the boundary walls, thus making it impossibe to extend further in that direction. It also brought it uncomfortably near to my largest gasholder.

It was not possible to extend at the other end of the existing horizontal retort house without taking down the power house and altering the coke handling and screening plant.

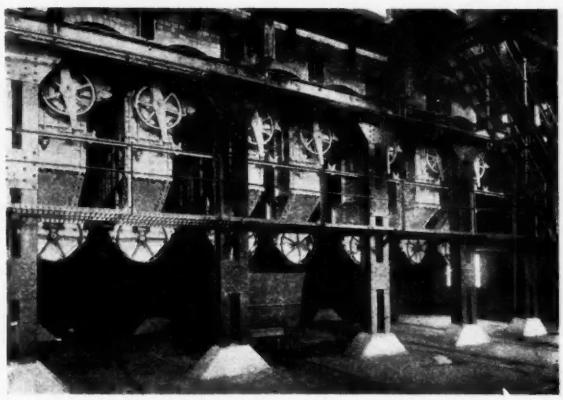
Although the four new beds, when working in conjunction with the remainder of the horizontal plant, would have taken care of our load for some years, I felt that, before committing my Company to a policy which at some future date would mean a complete new retort house on another site, with its consequent heavy capital expenditure, I should explore further avenues to see whether, by spending perhaps a little more at the time I could not save a heavy expense later.

The most obvious way to conserve ground space was to install a unit of continuous vertical retort plant at the end of the horizontal house, and as the horizontal beds became due for re-building, to add further vertical retorts until ultimately the whole gas-making plant was converted.

After inspecting various vertical retort installations, I obtained from the Woodall-Duckham Company a scheme and

approximate prices for a 750,000 cu.ft. per day vertical retort plant, arranged for future extension, together with a statement of savings expected over our horizontal retort method of working.

The scheme proved attractive, not only in so far as lay-out was concerned, but also as regards cost. As was to be expected, it was somewhat more expensive than a horizontal installation, but in compensation there was a substantial annual saving to be made. In addition, I found it would be possible to accommodate two benches of vertical retorts having a combined capacity of over 4 million cu.ft. of gas per day on the site of the horizontal retort house, and as our maximum output at that time was just over 1½ million cu.ft. per day, I felt that with this scheme it provided ample provision for future extension.



Vertical Retort Plant, Grimsby.

The saving to be effected by working the vertical retort plant in conjunction with the horizontals was estimated to be just under £2,000 per annum. As this was a very good return on the cost of the installation, I made up my mind to recommend the scheme to my Board. The only point about which I was a little doubtful was whether it would be as easy as the makers claimed to vary the calorific value of the gas made in the vertical retorts, and as the saving depended largely on the new plant's ability in this direction, it will be appreciated it was an important matter.

To obtain maximum benefit from the new plant, it was decided that it should work to capacity all the year round, and fluctuations in output be taken up by variation of the number of horizontal beds in operation. Even in those days, when the cause and effect of nitric oxide were not so much in our minds as they are to-day, I had found, from a purely financial aspect, that it did not pay to make 500 B.Th.U. gas by over-pulling. I was therefore very glad to think I would be able to make 560 B.Th.U. gas constantly in the horizontal plant, and vary the calorific value of the gas from the verticals so as to maintain a quality of 500 B.Th.U. into the holder. It will be gathered that at some periods of the year the verticals would be called upon to make 480 B.Th.U. gas, while at others, depending on the number of horizontal beds at work, they would have to make as low as 450 B.Th.U. gas.

In 1930, coke was not the valuable residual it has been in recent years, and the high yields of gas from the verticals, with a consequent diminution in coke made as a result of less coal being carbonized, were a great attraction. It was, of course, largely on account of these facts that we were able to show such a saving over horizontal working.

Another minor point which caused me some thought was that I would require to keep the two types of coke absolutely separate, and make certain that customers always had the same type of coke. I am pleased to be able to say that subsequent working has shown even better saving than we had estimated, that my fears regarding the flexibility of the vertical plant were groundless, and that little difficulty was experienced with the coke market.

In view of the excellent results which had been obtained at the works for many years from horizontal retorts, it was not easy to persuade my Directors to make the change. However, after investigating the matter from every point of view, they ultimately agreed, and an order was placed with the Woodall-Duckham Company for six 82-in. upwardly-heated retorts, complete with a natural draught waste-heat boiler. A new bucket elevator was included in the scheme for coal handling to the vertical retort plant, while the existing telpher was used for coke-handling; an electric lift was installed, however, to act as a stand-by to both coal and coke handling plants.

It is, perhaps, interesting to mention that the 82-in. upwardly-heated retorts were the first of their size and type to be built by the Woodall-Duckham Company, and they have given a very good account of themselves. I believe that many installations of similar design have since been constructed in various parts of the world, and are giving equal satisfaction. The vertical retort plant was first put to work on Oct. 12, 1932, and has been in continuous operation since that date. Last year we added four more retorts to the bench, and to enable all the gas to be made in one plant, we have just completed a second extension of four retorts this year, which were put to work on May 10 last, thereby completing the programme which we originally set ourselves to carry out in 1931. The latest addition includes a horizontal multi-tubular fire-tube boiler of the induced draught type, large enough to deal with the waste gases from 14 retorts, together with an induced draught fan with steam turbine drive.

There are now 14 82-in. retorts in the bench, and we are expecting to have to let down the six original retorts this year for their first repair.

It will be seen, therefore, that our maintenance cost on the original vertical retort plant has up to the present been a negligible figure, as only small replacements of castings have been carried out. Working the two plants in conjunction as we have done, it has not been possible to obtain separate figures for the operating results on each installation, and for comparison I therefore propose only to give the results which were being obtained during the year prior to the installation of the vertical retorts, and those for the years following the additions, including the installation of a benzole recovery plant.

Working Results.

Year.	Carbonizing Plant.	Make per Ton of Coal Carbonized.	Specific Gravity.	Average Calorific Value.	Coke for Sale per Ton of Coal Carbonized.
		Cu.Ft.		B.Th.U.	C. Q. Lb.
1931	All horizontals	14,730	0·452	503·2	10 0 16
1933	50% horizontals 50% verticals	16,250	0·490	503·4	9 1 10
1936	" "	16,400	0·492	502·3	9 2 18
1938	30% horizontals 70% verticals	15,765*	0·481	502·4	9 3 5

* 32,000 gallons crude benzole recovered.

In view of the savings made as a result of installing the vertical retort plant when we had an adverse coke-coal price ratio, it might be thought that now when there is a favourable coke-coal price ratio we would have benefited more in the long run by having kept to horizontals. However, it must be remembered that only part of the saving was due to this factor, and the installation of a benzole recovery plant gave us the opportunity of making a higher quality of gas in the vertical plant, with a consequent greater throughput of coal, and therefore more coke for sale.

Now that all our gas can be made in vertical retorts, we shall be able to take advantage of any coke position which may arise, as we can make 520 B.Th.U. gas and de-benzolize to 500 B.Th.U. when the coke market is good, or steam down to 500 B.Th.U. when it does not pay to make coke.

The gradual change in our method of gas-making has been very helpful. Coke users, who at first did not re-act very favourably to the lighter and freer burning vertical coke, have now been educated to its virtues.

Some of the coals we had used in our horizontal retorts for many years proved to be quite unsuitable for use in verticals. These include two South Yorkshire coals, which by reason of their rich highly swelling nature would not work freely, while another coal was eliminated by reason of its high sodium-

chloride content. Experience has shown that coals containing more than 0·2% of NaCl are liable under certain conditions to cause fluxing of the setting brickwork, and since this chloride may remain in the coke during carbonizing, it may be driven off from the coke in the producer into the combustion flues, and there re-act with the brickwork.

Difficulties have been experienced in our efforts to get coals to replace those considered to be unsuitable. The unfairness of the monopolistic powers given by the Government to the coal selling organizations have been encountered, in that we have had no choice, but have had to take coals that the organizations considered were available. At present coals from ten different collieries are being used, but the mixture and proportion of each is kept fairly constant. I consider it a sound policy to have a fairly wide selection of coals. We do not expect all sources of supply to fail at the same time, except in case of a national coal or railway stoppage. At one time I used all washed double nuts, but owing to increased coal prices, in an effort to reduce average cost per ton, a certain proportion of singles are now mixed with the doubles.

I have been greatly impressed by the performance of upwardly-heated vertical retorts, their flexibility, capacity, and ease of control, and I look forward to getting better results now that my gas-making plant is all verticals.

Distribution.

While not pioneers, my Company can claim to be one of the early users of steel mains for supplying high-pressure gas to outlying districts. A 6-in. steel main, 11 miles in length, was laid in 1911 to give a supply of gas to the Port of Immingham and villages en route. This main, with the exception of a length of about three miles at the works end, which has been replaced by a larger main, is still in use, and is giving every satisfaction. Short lengths of the main which have been cut out recently, when inserting tees to give a supply of gas to new estates show, on being carefully examined, no sign of internal or external corrosion. When laid, the pipes were oiled inside and coated externally with hessian wrapping and bitumen. Only on two occasions have we had leakages which have been caused by failure of the wall of the piping. In each instance the main was under a road which had a foundation of ironstone slag, and it is assumed that water penetrating the surface of the road liberated the sulphur in the slag, gradually eating through the wrapping and the wall of the pipe.

What we term our old town area is divided into two districts, and is supplied with gas at ordinary low pressure; No. 1 district through a 24-in. governor with trunk main of the same size, No. 2 district supplied through a 14-in. governor and 14-in. trunk main. The maximum initial pressure in each district is 48-tenths, with the exception of Sunday, when 2-tenths is added for two hours in the middle of the day to carry the dinner time load.

During the past few years, building estates have developed principally on the western and southern outskirts of Grimsby. Fewer houses to the acre, wider roads, and the greater use of reinforced concrete and bitumen in their construction have caused a serious increase in distribution costs. In order to meet the development, we decided after careful consideration to increase the size of existing high-pressure mains, and supply gas to the new areas through Reynold's governor sets, in duplicate. These have been housed in kiosks, which with the aid of suitable shrubs, have been made to harmonize with existing surroundings. It is interesting to note that my Company have altogether nine sets of these governors in use, and very often on the weekly records of their outlet pressures the variation from the predetermined pressure is not more than one-tenth of an inch water pressure.

The scheme of enlarging and extending our high-pressure distributing system was carried out in three stages over a period of three years at a cost of about £8,000. Steel mains were again used, of 10-in. and 9-in. diameter, with inserted joints for welding. Double-faced internal screw valves of the "Baurer" type were inserted every half-mile. They were fitted with open long sleeve sockets, with lead wool as a jointing material, and any syphons had joints of the same type. It is expected that the flexibility of this joint will take up any contraction or expansion that may occur in the pipe line. All joints were tested for soundness at a pressure of 50 lb. Working pressures in the main vary from 3 lb. per sq.in. to 8 lb. per sq.in. maximum at times of peak load. Compression is carried out by means of two steam driven "Brotherhood" compressors, one delivering 50,000 cu.ft. per hour and the other 100,000 cu.ft. per hour which takes up the peak load.

The moderate pressure to which we compress the gas has no deleterious effects. Consumers in the outer districts declare that their gas is of better quality than that supplied in Grimsby. This is probably due to the removal of water vapour from the gas by compression, and the constant pressure at which it is supplied. Actual tests taken at Immingham, after the gas has travelled 11 miles, show that the loss in calorific value is only very slight.

Gas Charges.

I have yet to be convinced that there is any virtue or sound business in selling gas at half the recognized price, *plus* a service charge. I have a feeling that very often such schemes are subsidized by the ordinary or domestic user, who in my opinion is the mainstay of our consumption. It has always been the policy of my Company to look upon him as such, and to keep the price of gas as reasonably low as possible, offering a scale of discounts as the consumption increases, conditional on prompt payment of accounts. Although we have power to charge extra in some of our outlying districts, our charges have been since 1933 the same throughout our whole area of supply. Simple methods of charging for gas inspire confidence in our consumers.

Recent legislation has given our Industry some relief, but we still have no means of avoiding loss on those who only use gas as a stand-by.

A gas undertaking's consumers are the prospects of its competitors. Good service, including regular maintenance of appliances is essential. Every one of our consumers is being attacked, and we must not neglect those already on our books by reserving our energy and courtesy for new prospects.

National Organizations.

We have heard and read a great deal lately about the unification of our National Bodies. It is a very debateable point whether an amalgamation of such would be the complete success some of its advocates contend. I believe that our Industry has suffered on more than one occasion in recent years by reason of the fact that it has not spoken with a strong and united voice. Our National Organizations as they now exist do give good service, which includes personal attention from those at the head of each. This personal aspect, which is so essential, might be lost if they all came under one head. Closer co-ordination could be arranged, with a standard subscription, and our future policy could be framed and controlled by an Executive of a limited number, embracing the best men from each of our present organizations, the Chairman of this Executive to be the recognized head of the Gas Industry.

Painting.

The new practice of allowing steel plates to oxidize until the shop-scale is removed before painting, has not yet been tested sufficiently to warrant its adoption. I have found that a good quality liquid lead paint makes an excellent priming coat on cast iron and steel work. It covers well, and is easily applied. The gasholders of my Company have been painted with a particular make of silica-grapholene paint for more than 30 years, and they are in a good state of preservation. This paint covers well, is easy to apply, though not a particularly quick drier, and tests show that it is a non-conductor. Our gasholders are painted every second year.

Women's Gas Council.

Grimsby can claim some little distinction in that, in the area covered by this Association, it is the only gas under-

taking (with the exception of Tottenham) that has a local Branch of this organization. Our Branch has been in existence for more than two years, and I have nothing but praise for the good work it has accomplished. Its membership is over 240, and their activities definitely promote good-will and gas-mindedness. The Lecture Room at our showrooms is to be enlarged, so that their growing membership may be more comfortably accommodated. I recommend this movement to you. Its greater development would give increased strength to our Industry.

Sales Commission Scheme for Employees.

For some years my Company have had in operation a Prospect Card Scheme. It is open to all employees, other than those actually on the sales staff. The payment of a small commission on the sale of gas apparatus which may result from enquiries they bring in is an inducement for fitters, service layers, lorry drivers, &c., to become active salesmen. Prospect Cards are put in a box, which is cleared daily by the Chief District Salesman. Enquiries are followed up by the sales staff, and each quarter, records of sales and commission paid to each employee are published. Last year 1,746 enquiries were received, which on being followed up resulted in the sale of 1,175 gas appliances. The commission paid totalled £70 11s. 5d. A good proportion of this is business that would not have been obtained but for the scheme.

Constancy of Composition.

All undertakings endeavour to supply gas of a constant calorific value; but constant composition and constant specific gravity are also necessary if industrial users are to get best results from the gas we supply. A large make per ton does not necessarily indicate good and effective carbonization. The cost of compressing and distributing gas increases with the rise in density. The direct supply of gas at high pressure is appreciated by some of our industrial consumers. By this means, capital costs of a compressing plant, and running costs of the same are eliminated. Meters made by two firms are being used for the purpose. Suitable governors fixed on the inlet ensure that the gas is measured at a constant pressure. A correction figure is used in order to arrive at the correct amount of gas supplied.

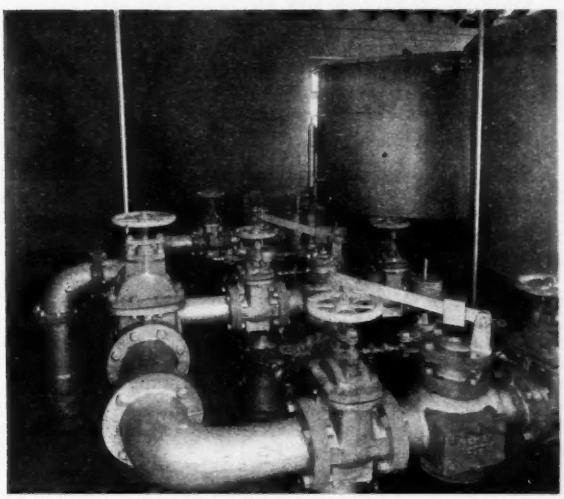
Gas Supply for Biscuit Baking.

A brief description of the gas installation at the very up-to-date biscuit factory of Messrs. Watmough & Son, Ltd., of Great Coates, will be of interest, particularly as we are looking forward to visiting this factory to-morrow.

The gas is supplied under high pressure through a 4-in. and a steel 6-in. steel main. Pressure to the inlet of the meters is regulated by three sets of Reynolds' governors, two in use, and the third acting as a stand-by. The amount of gas used is recorded by three No. 50 size "B. M." meters. A fourth meter is in reserve, ready in case of a breakdown, but up to the present it has not been necessary to use it. This type of meter is thoroughly reliable, and has given every satisfaction. It complies with the Sales of Gas Act, and is sealed by the Board of Trade Inspectors. There are no leather diaphragms to deteriorate or require replacement, and no sliding valves to wear, stick, or leak. Gas oil is used as a sealing medium. After the oil has become saturated with gas, it requires very little attention with regard to maintaining the proper level. Its use preserves and keeps clean the inside of the meter, and it will not freeze in winter.

Modern Equipment.

The governors and meters are housed in a separate building. The factory is laid out on very up-to-date and labour-saving lines, and all equipment is of the most modern type. The ovens, seven in number, with their necessary mixing machines and dough brakes, are fixed in parallel lines along the length of the factory. An axiom of the firm is "Never Leave the Line." All ingredients are mixed at one end of the plant, and, passing through the various processes, do not deviate from the straight line until the finished product is wrapped and packed in cartons ready for despatch. It is said that the oven is the heart of any biscuit making plant. However carefully the ingredients may have been selected, skilfully worked, and artistically designed, it is the baked product which must attract and gratify the consumer. This is where gas plays such an important part because of its reliability and ease of temperature control. All ovens are of the conveyor type, some fitted with steel bands for baking sweet and fancy biscuits of the soft dough type, and others are fitted with wire bands for baking biscuits of the semi-hard dough type, such as cream crackers and cabin biscuits. Gas is supplied to the latter at a slightly higher pressure because of the extra heat required in their baking.



Governors and Meters at Biscuit Factory.

The ovens were made by Baker, Perkins, Ltd., of Peterborough, and the burner equipment supplied and fitted by the Keith, Blackman Company. Slag wool and logs of a refractory material are used for heat conservation, and in order to reduce the attention to burners to a minimum, the recently installed ovens are fitted with air filtration plant in which the air required is passed over oiled plates to extract the dust.

Conclusion.

Athough the manager of a gas undertaking is never really "off duty," his responsibilities to the community he has the honour to serve should not finish with giving them a satisfactory gas supply. Civic, social, and welfare service, which can be rendered in so many different ways, should be given as fully as time and circumstance permit, and should be looked upon as a recreational duty.

I find my "daily round and common task" full of interest, and I have no fear with regard to the future of our Industry provided we pursue a sound national policy, and we are given fair legislation. Our production methods and sales policies must be kept right up-to-date. The Institution of Gas Engineers, which is stronger and more virile than ever, is giving a splendid lead in research work, and other investigations which concern us. There are still many fields to conquer, and ever increasing opportunities for service.

My membership of our Association has been a pleasure and a help to me, and I am glad to have the opportunity of repaying in a small measure the many kindnesses and hospitalities I have received from its members.

I thank my Directors for their help and the facilities they are giving me so that I may serve you, and in conclusion I should like to pay tribute to my staff and all employees for their loyal support at all times.

To quote Robert Browning:

"Great friendships, great duties, and noble purposes
Make man seem a part of the world itself."

Twenty Years at St. Ives

by

F. R. G. GRANT, M.Inst.Gas E.

Presidential Address read at Truro before the Cornish Gas Association, May 11, 1939

THE PRESIDENT.

It may not be amiss at this time and also of interest to you to know that my service to the Gas Industry is now in its forty-ninth year. It was in January, 1890, that my career as a Gas Engineer was started as a pupil apprentice with the firm of Henry Balfour & Co., then a private company, of Leven, Fifeshire. It is very gratifying to me to know that this firm, which is one of the oldest gas engineering contracting firms in this country, and at one time perhaps the best known in the world, is to-day in a state of prosperity. Many men famous in the Industry had a connexion with that firm, names such as Anderson, Morton, Wilson, and Terrace.

As it appears to be the custom recently for Presidents of Associations to give in their Address an account of the undertaking which they manage, you will forgive me if I follow the example of better men than myself and as briefly as possible give you some account of the Undertaking at St. Ives during the last 20 years, the length of my stay there.

Of course, when I went there in January, 1919, the Great War had recently ended, and so for a period of four years very little had been done in the way of repairs and renewals. The fact, however, remained that the works as well as the district were in a very bad state, and in addition the finances of the Undertaking were in a state of collapse. Without further explanation you must accept the fact that my "back was against the wall" from the very start.

The works were purchased from a company by the St. Ives Corporation in 1895, when they were remodelled to give a maximum output of 20 millions. A great error of judgment was made at that time in not moving the works to a site which was then available and which would have allowed for future expansion, apart from being an altogether better site. The present site is practically the side of a hill, or, to make it more clear, the foundations of the high-pressure holder are 40 ft. higher than the level of the entrance to the works.

The Works as They Were.

Let me give a short description of the works as they were in 1919. The carbonizing plant consisted of three settings of sixes. All these were in a bad state of repair as were two of the three producers. There were two exhausters, one of 10,000 and the other of 5,000 cu.ft. per hour. These were both in very fair condition; in fact, the larger one is still in use. They were, and still are, gas engine driven, both the engines were in a bad state, one, the smaller of the two, being completely worn out as well as being too small for the job. The condensers, of the annular type, were in a very bad state and had been out of action for some time; we were, however, able to get them to work again after extensive repairs had been carried out. The Livesey washer, which had been put down a few years previously, was in a good condition and is still at work as is the tower scrubber. There were four purifiers, three of these being 6 ft. square and made of steel with water-sealed covers, and one 10 ft. cast iron with rubber-sealed cover. These were worked from a water-sealed centre valve. The three steel boxes were all leaking in places, though they had been patched many times, and were thickly coated with rust.

The station meter of 3,000 cu.ft. per hour capacity was registering inaccurately, and so the drum had to be renewed at once.

The station governor was of the mushroom type valve, and as this was liable to shut up completely at times the by-pass valve had to be kept open continuously.

Coming now to storage, there was one single-lift holder of 40,000 cu.ft. capacity throwing only 3½ in. pressure. Numbers of the sheets were very thin, especially on the crown, and were a mass of patches. The second holder of 5,000 cu.ft. capacity was completely done and had been out of action for some time. There was no real office at the works and only a very small workshop.

To turn to the district, many of the mains were very old and much too small, so that with an initial pressure of only 3½ in. at the works the drop in pressure in some parts was very great. As a result of this, and the uncertainty of a supply of gas at all, many consumers had entirely given up using gas for coal and oil. There was, however, one thing to be thankful for. Electricity had not yet come to St. Ives.

There was no showroom and no fittings department at all. The number of street lamps was about 200, all square lanterns, 150 of which were fitted with flat flame burners. The price of gas was 5s. 6d. per 1,000 cu.ft.

These were the conditions which prevailed at St. Ives in 1919. The first thing that had to be done was to approach the Board of Trade and apply for leave to increase the price to 7s. 6d. under the Temporary Increase of Charges Order. This was granted and the price was raised to 7s. 6d. at once, a not too popular thing to do.

The next step was to consider what were the most essential things to be done at the works and on the district. The stokers' hours were reduced from 12 hours to 8 hours and all the other men were granted an eight-hour day. It was also decided to build a cabin for the stokers adjoining the retort house.

Two of the settings of retorts were renewed together with the producers. Part of an old coal store was converted into a stores with an office above. A gas engine was installed in place of the smaller of the two existing ones.

Storage and Pressure.

This left the question of storage and pressure, and so it was decided to add a lift to the existing holder; this would bring the capacity to 78,000 cu.ft. and the pressure thrown to 6½ in. To enable this to be done, the walls of the smaller holder tank were heightened and a two-lift holder of a capacity of 16,000 ft. was installed. This holder gives 7½ in. pressure. This was in use while the larger one was being telescoped. You will easily understand that some anxious times were gone through while this small holder was the only one available. With the greater pressure on the district and after a 3 in. main had been replaced with one of 6 in. diameter we were able to approach our consumers with more confidence and also to canvass for new ones. These latter came along so rapidly that in 1922 we had to relay some old mains with larger ones and also lay new mains.

Due to the increased output in 1926 one of the beds of six retorts was taken out and a new setting of eight retorts erected. In the same year two 10 ft. purifiers were laid down in place of the three small steel boxes, together with connexions and valves, provision being made for another box later. A new gas engine was fixed in place of the remaining old one and a 10,000 cu.ft. exhauster in place of the existing 5,000 cu.ft. exhauster. Several new mains were laid and also old ones relayed with larger ones.

Again in 1931, due to the great increase in output, the

whole question of carbonization had to be considered. It was eventually decided to install vertical retorts. They are of the Woodall-Duckham continuous type and consist of three 44 in. retorts with house large enough to take a further retort. A waste-heat boiler was also installed with the plant as well as a coke hopper.

In 1932 a new annular condenser was supplied by the Whessoe Engineering Company, of Darlington. This is rectangular in shape 4 ft. 6 in. by 3 ft. by 16 ft. high with 24 6-in. pipes together with a damper to regulate the flow of air. The fourth purifier, 10 ft. square, was added in that year.

A new station meter was installed in 1936. Capacity 8,000 cu.ft. per hour.

In 1937, mainly due to the expansion of output but also to the enlargement of the Borough by the incorporation of Carbis Bay, which entailed the laying of five miles of additional mains, it was decided to inaugurate a high-pressure scheme, which included a high-pressure storage vessel of a capacity of 152,000 cu.ft. at 50 lb. pressure, a compressor of the reciprocating type, one set of high-pressure governors, and two sets of district governors, as well as several pressure raising governors on the district. As you heard a Paper on this scheme last year there is no need for me to go further into that again other than to say it is working perfectly. It is, as far as I am aware, the second of its kind in the country. The possibilities of a high-pressure distribution are very great, and after many years' experience I am convinced that it will be one of the chief means of not only retaining but also gaining many valuable loads for the Industry.

Let me now give you a few figures to show how rapid has been the growth of the output at St. Ives:

—	Make in Millions.	Consumers.
1919..	12	750
1924..	20·8	1,030
1929..	30	1,422
1934..	39	1,864
1939..	48	2,400

Regarding street lighting, there are now 322 lamps of which number 80 are square lanterns. No lamp has less than two mantles, and with the exception of one 4-mantle bijou lamp and one high-pressure lamp, No. 2 size mantles are used throughout. It is the practice to replace all obsolete square lanterns with inverted lamps. One hundred and eleven of the lamps are clock controlled and it is intended to clock the remainder as soon as possible.

Of course, there is no industrial load in St. Ives, and with the exception of two installations for central heating and one fish shop the whole of the output is domestic. The aim has therefore been to cater for that load in every possible way.

In 1935 a block system of charges was introduced, and in spite of the price having to be increased twice, mainly due to the higher price of coal, 6s. 6d. in three years, the present price of gas is from 5s. 6d.-3s. 10d. Another factor in keeping the domestic load has been a system of free maintenance, the only charge being for materials used.

A new and a larger showroom was opened last year, and has proved of great benefit both to the consumer and to the Undertaking.

Staff Training.

We have always trained our own fitters; they come to us for a five years' apprenticeship. At least six months of that period has to be spent on the works so as to enable them to get a knowledge of the processes carried on there. They then, when on the district, have a knowledge of what gas really is. They are also expected to attend evening classes and take the examinations required. We all have one motive and that is Service.

Like most undertakings in Cornwall we have a ready sale for coke at a fair price and never hold large stocks. About 70% of the coke sold is broken. If my memory serves me right St. Ives was the first place in Cornwall to break coke.

In 1923 we were forced under the Gas Regulation Act to sell gas on a therm basis.

During the 20 years a capital expenditure of £38,000 has been incurred. The outstanding loans amount to £550 per million cu.ft. of gas sold.

It may seem to you, at first, a strange thing for me to say, but I maintain that in certain circumstances the growth of an undertaking may be too rapid, and as a result it may be crippled financially. In an undertaking like St. Ives where the number of consumers is increasing yearly by about 100, or in some years by many more, the expenditure is out of all proportion to the return in revenue. This is accentuated when at least 90% of this increase is through prepayment meters, the consumption in many cases being very small indeed. This means that the older and especially the larger consumers are being penalized to pay for this extra cost, and it is bound to affect adversely the price of gas. This goes to prove that the Board of Trade or whoever is responsible will have to pay attention to the findings of the Joint Committee on Gas Prices as well as to those of that independent commission which recently issued its report. I refer to the PEP. They will have to give the Gas Industry the right to make each class of consumer bear his fair share of the undertaking's commitments. We are not asking for any favour but only for fair play and to be placed on a sound business footing as well as on an equality with our chief competitor. The Gas Industry has given good service to the community for many years now, and is doing so to-day. Its service in the last War must not be forgotten. The whole matter is a business one and must be treated as such.

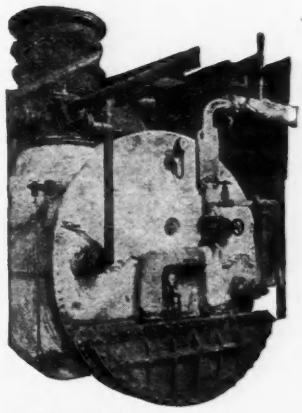
Before closing I would like to pay tribute, as did the President of the North British Association, to the Technical Press. Their work and service to those of us who are unable to attend many meetings is invaluable. They keep us in touch with all that is being done in the interests of the Industry. One might almost call their weekly arrival a Refresher Course.

Permac
METAL-TO-METAL JOINTING MATERIAL

"Permac" gives a *permanent* metal-to-metal joint! It never varies, making a joint that lasts till you want to break it down. Ever since 1913 "Permac" has been holding up difficult joints on Gas and Coke Oven Plants all over the world. Equally suitable on any kind of joint—steam, water, gas, oil.

● *Send for particulars to the makers:*

THOMAS & BISHOP LTD.
37 TABERNACLE STREET, LONDON, E.C.2
Telephone: Clerkenwell 3351/2 *Telegrams:* "Velcling," London



"Permac" joints on a large Coke Oven Plant.

Markets and Manufactures

Current Sales of Gas Products

The London Market

May 29.

There are no alterations to record in the values of Tar Products in the London markets, present prices being as follows:

Pitch, nominal, at about 26s. per ton f.o.b.
Creosote, about 3½d. to 3¾d.
Refined tar, 3¾d.
Pure toluole, about 2s. 5d. to 2s. 6d.
Pure benzole, about 1s. 9d.
95/160 solvent naphtha, 1s. 7d. to 1s. 8d.
90/160 pyridine, about 11s.
All per gallon naked at makers' works.

The Provinces

May 29.

Crude Gas-Works Tar, 12s. to 17s.

To avoid misunderstanding, it is necessary to state that the above price is not claimed to represent a market value. It is a price worked out from week to week upon a system which has been used for many years as a basis for the fixing of certain contracts for crude tar of varying qualities in different areas.

The average prices of gas-works products during the week were: Pitch—East Coast, 27s. to 28s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 27s. to 28s.* Toluole, naked, North, 1s. 10d. to 1s. 11d. Coal tar, crude naphtha, in bulk, North 7¾d. to 8¼d. Solvent naphtha, naked, North, 1s. 4¼d. to 1s. 5d. Heavy naphtha, North, 1s. 2¼d. to 1s. 3d. Creosote, *ex* works, in bulk, North, liquid and salty, 3⅜d. to 4⅛d.; low gravity, 4d. to 4¼d. Carbolic acid, 60's, 1s. 7d. to 1s. 10d. Naphthalene, £13 10s. to £16. Salts, 70s. to 75s., bags included. Anthracene, "A" quality, 4¼d. to 4½d. per minimum 40% purely nominal; "B" quality unsaleable. Heavy oil: Unfiltered anthracene oil, min. gr. 1,080, 4⅜d. to 4⅝d.; filtered anthracene oil, min. gr. 1,080, 5¼d. to 5⅜d.; heavy tar oil, gr. less than 1,080, 4¼d. to 4⅜d.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls, whatever they may be.

Scotland

GLASGOW, *May* 27.

Market is still suffering from a lack of orders although enquiries continue quite numerous. Prices remain easy.

Crude gas-works tar.—Actual value is now about 29s. to 30s. per ton *ex* works in bulk.

Pitch of vertical quality is valued at 20s. to 21s. per ton f.o.b. for export and round 20s. per ton *ex* works in bulk for home trade.

Refined tar.—In the home market prices remain at 3¾d. to 4d. per gallon, while for export competition is keen at round 2¾d. to 3d. per gallon, both into buyers' packages at makers' works.

Creosote oil.—Fairly steady business is taking place in all grades with prices as under: Specification oil, 3½d. to 3¾d. per gallon; low gravity, 4¼d. to 4½d. per gallon; neutral oil, 3¾d. to 4d. per gallon; all *ex* works in bulk.

Cresylic acid is still very difficult and makers are offering freely as under: Pale, 97/99%, 1s. 2d. to 1s. 3d. per gallon; dark, 97/99%, 1s. to 1s. 1d. per gallon; pale, 99/100%, 1s. 4d. to 1s. 7d. per gallon; all *ex* works in buyers' packages.

Crude naphtha.—Supplies are limited and value is unchanged at round 5d. to 5¼d. per gallon *ex* works in bulk, according to quality.

Solvent naphtha.—90/160 grade is round 1s. 3½d. to 1s. 4½d. per gallon, and 90/190 heavy naphtha is about 1s. 1d. to 1s. 2d. per gallon.

Motor benzole is 1s. 3d. to 1s. 4d. per gallon.

Pyridine.—90/160 grade is 8s. 6d. to 9s. 6d. per gallon, and 90/140 grade is 9s. 6d. to 10s. 6d. per gallon.

Benzole Prices

These are considered to be the market prices for benzole at the present time:

	s.	d.		s.	d.	
Crude benzole..	0	9½	to	0	10	per gall. at works
Motor ,, ..	1	3	,,	1	3¾	,, ,, ,,
90% ,, ..	1	4	,,	1	4½	,, ,, ,,
Pure ,, ..	1	8	,,	1	8½	,, ,, ,,

Contracts Advertised To-Day

Coal.
Blackpool Gas Department. [p. 690.]
Wallasey Gas Department. [p. 690.]

Gasholder.
Rhyl Gas Department. [p. 690.]

Generating Set.
Lincoln Gas Department. [p. 690.]

Mobile Conveyors.
Blackpool Gas Department. [p. 690.]

Oxide.
City of Carlisle Gas Department. [p. 690.]

Purifiers.
Sutton-in-Ashfield Gas Department. [p. 690.]

Flavels, of Leamington

Messrs. Sidney Flavel & Co., Ltd., issue a cordial invitation to Gas Engineers and their friends to visit their London Galleries, 38, Welbeck Street, W. 1, during Institution Week.

Dividend Announcement

Plymouth and Stonehouse.—The Directors of the Plymouth and Stonehouse Gas Light and Coke Company have recommended payment of the following dividends on July 1, 1939, for the half-year to March 31 last: At the rate of 4% actual on the ordinary stock (making 7⅞% for the year; 13s. 6d. per share on the additional shares (making 26s. 6d. per share for the year), 13s. per share on the new shares (making 25s. 6d. per share for the year), less income tax.

PROTECT WITH

METROTECT

a bituminous paint producing a pleasant satin black finish with highly waterproof and anti-corrosive properties.

Protects steel-work which is continuously or periodically immersed in water. Does not become brittle on prolonged atmospheric exposure. METROTECT flows freely under the brush and can be applied quickly and without effort even in cold weather.

Prices and further particulars from—

SOUTH METROPOLITAN GAS CO.

PRODUCTS DEPARTMENT,
REGIS HOUSE,
KING WILLIAM STREET,
E.C.4.

GAS STOCKS AND SHARES

There was a welcome broadening of business on the Stock Exchange last week, and, judging from the volume of enquiries towards the close, it appears evident that, in the absence of political disturbances, still brighter conditions may prevail during the current week. Gilt-edged securities again gave the lead, and, although these, together with industrials, received the heaviest support, almost every other market shared in the revival. Further improvements also took place in home rails, especially at the end of the week when the award of higher fares in the London area gave a fillip to Transport "C" stock, which hardened 8 points.

The gas market participated in the brighter conditions, the number of recorded transactions being not only heavier, but covering a wider range of stocks than for some time past. Imperial Continental made the best showing in the Official List with a gain of 8 to 123½, and, although usually readily obtainable, such has been the demand for this stock that at the time of writing there is none on offer. Plymouth and Wandsworth moved up 2 points each to 115 and 114½ respectively, and South Metropolitan gained a further point to 92½. Several fixed-interest stocks also hardened, including increases of 3 points each is Gas Light 3½% maximum and Wandsworth 4% preference. The only fall of note occurred in Harrogate consolidated, which was marked down 12 to 98, a price more comparable with existing values.

Except for the increase of 4½d. in Newcastle units to 20s. 10½d. and a fractional improvement in Hartlepool consolidated, no alterations took place at the Provincial Exchanges. In the Supplementary List, apart from reactions in Bognor stocks, nominal quotations also closed unchanged.

Two high-yielding perpetual debenture stocks on offer at the present time are the Folkestone 5% and South Suburban 5%. Both are available at 112 to yield £4 9s. 3d. %, while a parcel of Tottenham 4% is on offer at 94 to give a return of £4 5s. 3d.%.

Official Quotations on the London Stock Exchange

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 26.	Rise or Fall on Week.
1,767,439	Mar. 6	8	8	Alliance & Dublin Ord. ...	130—140	...
374,000	Dec. 19	4	4	Do. 4 p.c. Deb. ...	90—95	...
877,576	May 8	5	5	Ascd. Gas & Water U'd'ts Ord.	16/6—18/6	...
500,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	18/6—20/6	...
535,545	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	17/—19/—	−1/6
318,730	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	16/—18/—	...
750,000	Mar. 6	3½	3½	Do. 3½ p.c. Red. Deb. ...	92—97	...
560,070	Feb. 20	7	7	Barnet Ord. 7 p.c.	153—158	...
300,000	Apl. 6	1/4½	1/9½	Bombay, Ltd.	18/6—20/6	+−/6
181,185	Feb. 20	9½	9½	Bournemouth sliding scale ...	192—202	...
690,526	,,	7	7	Do. 7 p.c. max. ..	153—158	...
493,960	,,	6	6	Do. 6 p.c. Pref. ..	127—132	...
50,000	Dec. 19	3	3	Do. 3 p.c. Deb. ..	70—75	...
362,025	,,	4	4	Do. 4 p.c. Deb. ..	95—100	...
335,000	,,	5	5	Do. 5 p.c. Deb. ..	110—115	...
357,900	Feb. 20	7½	7½	Brighton, &c., 6 p.c. Con. ..	135—140	...
659,955	,,	6½	6½	Do. 5 p.c. Con. ..	118—123	...
205,500	,,	6	6	Do. 6 p.c. 'B' Pref.	110—120	..
855,000	Mar. 20	7	8	British Ord.	107—117	−3
100,000	Dec. 19	7	7	Do. 7 p.c. Pref.	138—143	...
350,000	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115	...
120,000	,,	4	4	Do. 4 p.c. Red. Deb. ...	93—98	...
450,000	,,	5	5	Do. 5 p.c. Red. Deb. ...	100—105	...
450,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...
100,000	22 May '33	6	4	Cape Town, Ltd.	¾—1¼	...
100,000	6 Nov. '33	4½	4½	Do. 4½ p.c. Pref. ...	1—2	...
150,000	Dec. 19	4½	4½	Do. 4½ p.c. Deb. ...	60—70	...
626,860	Feb. 6	6	6	Cardiff Con. Ord.	112—117	...
237,860	Dec. 19	5	5	Do. 5 p.c. Red. Deb. ...	103—108	...
98,936	Mar. 20	2/—	2/—	Colombo Ord.	1⅞—1⅞	...
24,510	,,	1/4½	1/4½	Do. 7 p.c. Pref.	22/—24/—	...
739,453	Mar. 20	−/11·48	−/11·48	Colonial Gas Assn. Ltd. Ord.	16/—18/—	...
296,144	,,	1/3·30	1/3·30	Do. 8 p.c. Pref. ...	23/—25/—	...
1,775,005	Jan. 23	5	4	Commercial Ord.	52—57	−½
140,000	Feb. 6	§13/4	4	Do. 4 p.c. Red. Pref. ...	95—100	...
620,000	Dec. 5	3	3	Do. 3 p.c. Deb. ...	60—65	...
286,344	Feb. 20	5	5	Do. 5 p.c. Deb. ...	103—108	...
200,000	,,	§4	4	Do. 3½ p.c. Red. Deb. ...	95—100	...
807,560	Feb. 20	7	7	Croydon sliding scale ...	123—128	...
644,590	,,	5	5	Do. max. div.	94—99	...
620,385	Dec. 19	5	5	Do. 5 p.c. Deb. ...	108—113	...
239,000	Feb. 6	5	5	East Hull Ord. 5 p.c. ...	88—93	...
187,215	Feb. 6	6	6	East Surrey Ord. 5 p.c. ...	105—110	.
176,211	Dec. 5	5	5	Do. 5 p.c. Deb ...	107—112	...
250,000	Nov. 7	8	4	Gas Consolidation Ord. 'B' ...	19/—21/-	..
250,000	May 22	4	4	Do. 4 p.c. Red. Cum. Pref.	17/—19/-*	−−/6
19,189,963	Feb. 6	5§	5§	Gas Light & Coke Ord. ...	21/3—22/3a	..
2,600,000	,,	3½	3½	Do. 3½ p.c. max. ...	68—73	+3
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref. ...	91—96	+1
2,993,000	Jan. 9	3§	3§	Do. 3§ p.c. Red. Pref. ...	92—97	...
8,602,497	May 22	3	3	Do. 3 p.c. Con. Deb. ...	70—75*	−1
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb. ...	105—110*	..
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	101—106*	−1
700,000	Mar. 6	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...
270,466	Feb. 20	6	6	Harrogate New Cons. ...	93—103	−12
157,500	Mar. 20	‡1/—	‡1/—	Hong Kong and China Ord. ...	⅝—¾	...
213,200	Feb. 6	5§	6	Hornsey Con. 3½ p.c. ...	97—102	...
5,600,000	May 8	8	12	Imperial Continental Cap. ...	121—126	+8
172,810	Jan. 23	3½	3½	Do. 3½ p.c. Red. Deb. ...	87—92	...
235,242	Mar. 6	8½	8½	Lea Bridge 5 p.c. Ord. ...	145—155	...
63,480	Dec. 19	3	3	Maidstone 3 p.c. Deb. ...	58—63	..
45,000	May 22	†10	†10	Malta & Mediterranean Metropolitan (of Melbourne)	125—130*	−5
392,000	Apl. 6	5½	5½	5½ p.c. Red. Deb.	98—103	...
231,977	Feb. 20	5	5	M.S. Utility 'C' Cons. ...	95—100	...
968,658	,,	4	4	Do. 4 p.c. Cons. Pref. ...	83—88	...
390,076	Dec. 19	4	4	M.S. Utility 4 p.c. Deb. ...	90—95	...
148,955	,,	5	5	Do. 5 p.c. Deb. ...	107—112	...
125,000	Jan. 3	3½	3½	Do. 3½ p.c. Red. Bds.	94—97	...
675,000	May 8	†6	†3	Montevideo, Ltd.	63—68*	...
250,000	Mar. 6	7½	7½	North Middlesex 6 p.c. Con.	135—140	...
396,160	Feb. 6	5	5	Northampton 5 p.c. max. ...	103—108	...
300,000	April 24	†9	†7	Oriental, Ltd.	135—145	...
468,537	Dec. 5	8	7½	Plymouth & Stonehouse 5 p.c.	110—120	+2
621,667	Feb. 20	8½	8½	Portsmouth & Gosport Cons.	135—145	...
241,446	,,	5	5	Do. 5 p.c. max. ...	98—103	...
73,350	,,	5	5	Do. 5 p.c. Pref. ...	102—107	...
75,000	,,	4	4	Do. 4 p.c. Pref. ...	82—87	...
114,000	Feb. 6	5	5	Preston 5 p.c. Pref.	102—107	...
247,966	Dec. 19	4	4	Primitiva 4 p.c. Cons. Deb. ...	96—101	...
625,959	Jan. 9	4	4	Do. 4 p.c. Red. Deb. ...	94—99	...
15,000	Mar. 6	6	6	San Paulo 6 p.c. Cum. Pref. ...	8—9	...
441,275	May 8	1/1½	1/1½	Severn Val. Gas Cor. Ld. Ord.	20/—22/—	...
460,810	Mar. 20	−/10⅝	−/10⅝	,, ,, 4½ p.c. Cum. Pref.	19/—21/—	...
133,201	Mar. 6	8½	5	Shrewsbury 5 p.c. Ord. ...	141—146	...
9,000	June 3	4	‡4	South African Ord.	4½—5½	...
1,371,752	April 24	1/2⅝	1/2⅝	South East'n Gas Cn. Ld. Ord.	20/6—22/6	...
871,636	Mar. 6	−/10⅝	−/10⅝	Do. 4½ p.c. Red. Cum. Pref.	19/—21/—	...
498,818	,,	4	4	Do. 4 p.c. Cum. Pref. ...	17/—19/—	...
450,000	Feb. 6	4	4	Do. 4 p.c. Deb.	95—100	...
150,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...
6,709,895	Feb. 6	5	6	South Met. Ord.	91—94	+1
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pref. ...	118—123	...
850,000	,,	4	4	Do. 4 p.c. Irred. Pref. ...	85—90	...
1,895,445	Dec. 19	3	3	Do. 3 p.c. Deb.	67—72	...
1,000,000	Jan. 9	5	5	Do. 5 p.c. Red. Deb. ...	105—109	+1
600,000	,,	§31/—	3½	Do. 3½ p.c. Red. Deb. ...	93—98	...
1,543,795	Jan. 23	6	6	South Suburban Ord. 5 p.c. ...	105—110	...
512,825	,,	5	5	Do. 5 p.c. Pref.	103—108	...
500,000	,,	4	4	Do. 4 p.c. Pref.	85—90	+2
250,000	,,	3§	3§	Do. 3§ p.c. Red. Pref. ...	90—95	...
888,587	Dec. 5	5	5	Do. 5 p.c. Deb.	107—112	...
250,000	,,	4	4	Do. 4 p.c. Deb.	90—95	...
200,000	Feb. 6	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...
427,859	Apl. 6	9§	1/2§	S. Western Gas & Water Ord.	15/6—17/6	...
160,523	Apl. 6	−/10§	−/10§	Do. 4½ p.c. Red. Cum. Pf.	18/6—20/6	...
110,000	Dec. 19	4	4	Do. 4 p.c. Red. Deb. ...	93—98	...
750,541	Feb. 6	5	5½	Southampton Ord. 5 p.c. ...	104—109	...
148,836	Dec. 19	4	4	Do. 4 p.c. Deb.	90—95	...
350,000	Feb. 6	5½	5½	Swansea 5½ p.c. Red. Pref. ...	104—109	...
200,000	Dec. 19	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...
1,076,490	Feb. 20	6½	6½	Tottenham and District Ord.	105—115	...
409,835	,,	5½	5½	Do. 5½ p.c. Pref.	110—115	...
62,235	,,	5	5	Do. 5 p.c. Pref.	103—108	...
453,380	Dec. 5	4	4	Do. 4 p.c. Deb.	90—95	...
85,701	Jan. 9	6	6	Tuscan 6 p.c. Red. Deb. ...	95—100	...
1,131,550	May 8	4	6	U. Kingdom Gas Cor. Ord. ...	15/6—17/6	...
1,051,280	May 8	4½	4½	Do. 4½ p.c. 1st Cum. Pref.	17/—19/—	...
762,241	,,	4	4	Do. 4 p.c. 1st Red. Cum. Pf.	18/—20/—	...
745,263	Dec. 19	4½	4½	Do. 4½ p.c. 2nd Non-Cum. Pf.	14/—16/—	...
1,066,186	Mar. 6	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...
378,106	Mar. 6	7	7	Uxbridge, &c., 5 p.c.	120—125	...
133,010	,,	5	5	Do. 5 p.c. Pref. ...	102—107	...
1,371,138	Jan. 23	7	7	Wandsworth Consolidated ...	112—117	+2
2,525,768	,,	4	4	Do. 4 p.c. Pref. ...	85—90	+3
1,343,964	Dec. 19	5	5	Do. 5 p.c. Deb. ...	107—112	...
383,745	,,	4	4	Do. 4 p.c. Deb. ...	90—95	...
400,000	,,	§25/—	3§	Do. 3§ p.c. Red. Deb. ...	93—98	...
558,342	Feb. 6	6§	6§	Watford and St. Albans Ord.	105—115	...
200,000	,,	5	5	Do. 5 p.c. Pref. ...	98—103	...
200,000	,,	5§	5§	Do. 5§ p.c. Pref. ...	110—115	...
200,000	,,	§16/8	4	Do. 4 p.c. Rd. Pf. (1973/8)	93—98	...
100,000	—	—	—	Do. 4 p.c. Red. Pf. (1959)	97—102	...
200,000	Dec. 19	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...
200,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...

a.—The quotation is per £1 of stock. * Ex. div. † Paid free of income-tax. ‡ For year. § Actual.

Supplementary List and Provincial Exchanges overleaf.

STOCK AND SHARE LIST—Cont.

Supplementary List, not Officially Quoted, London

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Nominal Quotations May 26.	Rise or Fall on Week.
202,152	Mar. 20	5	5	Ascot Ord.	99—104	...
128,182	Dec. 19	5	5	Do. 5 p.c. Pref.	102—107	...
31,035	Mar. 20	–/4†	–/4†	Associated Utilities 4 p.c. Pref.	15/—17/-	..
100,000	Dec. 19	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100	.
17,000	Feb. 20	8	8	Bognor Orig. Ord. 'A' ..	140—150	– 2
62,210	,,	8	8	Do. New Addl. 'A' ...	140—150	– 2
87,160	,,	7	7	Do. New 7 p.c. max. ...	135—145	– 5
37,440	Feb. 6	10	10	Cam. Univ. & Town 10 p.c. max.	165—175	..
125,970	,,	7	7	Do. 7 p.c. max.	115—125	..
39,025	,,	5	5	Do. 5 p.c. max.	95—100	..
96,410	Feb. 6	4½	4½	Cardiff 4½ p.c. Pref.	93—98	...
150,000	Feb. 20	4	4	Croydon 4 p.c. Pref.	91—96	..
130 000	Dec. 19	4	4	Do. 4 p.c. Deb.	92—97	..
65,000	Mar. 6	7½	7½	Eastbourne 'A' 5 p.c.	122—132	..
198,000	,,	6	6½	Do. 'B' 3½ p.c.	105—115	..
112,312	,,	5	5	Do. 5 p.c. Pref.	102—107	..
130,000	Dec. 19	5	5	Do. 5 p.c. Deb.	107—112	..
24,000	Feb. 20	8½	8½	Great Yarmouth 8½ p.c. max.	30—35	..
59,400	,,	7½	7½	Do 7½ p.c. max.	27—32	..
51,160	Dec. 5	5½	5½	Do. 5½ p.c. Deb.	117—122	..
152,600	Feb. 20	8	9	Guildford Cons.	150—160	...
54,055	,,	5	5	Do. 5 p.c. Pref.	102—107	...
68,250	Dec. 19	5	5	Do. 5 p.c. Deb.	105—110	...
156,600	Feb. 20	7	7	Hampton Court Cons. ...	103—113	..
80,000	Mar. 6	4	4	Lea Bridge 4 p.c. Pref. ...	82—87	...
60,000	,,	6	6	Do. 6 p.c. Pref.	118—123	...
94,876	Dec. 5	4	4	Do. 4 p.c. Deb.	87—92	...
73,620	Mar. 6	8½	8½	Luton Cons. 'A'	150—160	..
107,960	Mar. 20	4	5½	Mid Kent Ord.	8½—9½	...
230,940	Feb. 6	10	10	Oxford & District Ord. ...	165—175	...
47,112	,,	5	5	Do. 5 p.c. Pref.	102—107	...
50,000	,,	6	6	Do. 6 p.c. Red. Pref. ...	108—113	...
126,193	May 8	7½	7½	Peterborough Ord.	134—139	...
64,990	Mar. 6	7½	7½	Redditch Ord....	115—125	...
166,850	Feb. 6	8	8	Romford Ord....	137—142	...
60,000	,,	4	4	Do. 4 p.c. Pref.	97—102	...
44,000	Mar. 20	5	5	Do. 5 p.c. Deb.	107—112	...
25,570	Feb. 6	5½	5½	Rugby 5½ p.c. Pref.	118—123	...
25,000	,,	6	6	Do. 6 p.c. Red. Pref. ...	103—108	...
42,750	Dec. 5	5½	5½	Do. 5½ p.c. Deb.	115—120	...
110,950	Feb. 20	8	8	Ryde Ord.	137—147	...
270,086	Mar. 20	7	7	Slough Ord.	120—130	...
21,000	Dec. 19	5	5	Do. 5 p.c. Deb.	105—110	...
28,872	May 8	5½	5½	S. Midland Gas Cpn. Ltd. Ord.	16/—18/-	...
28,866	Mar. 6	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	17/—19/-	...
117,228	Feb. 20	5	7	Swindon Cons.	100—105	...
60,425	Dec. 5	5	5	Do. 5 p.c. Deb.	105—110	...
64,380	Dec. 19	5	5	Torquay & Paignton 5 p.c. Pref.	102—107	...
130,000	Feb. 6	5	8	Wakefield Ord.	116—121	...
81,650	,,	5	5	Do. 5 p.c. max.	92—97	...
82,000	Jan. 23	6	6	Weymouth Ord.	101—106	...
98,384	Feb. 6	6	6	Wolverhampton 6 p.c. Pref.	115—120	...
160,000	Dec. 19	5½	5½	Do. 5½ p.c. Rd. Db.	103—108	...
50,000	Dec. 19	5	5	York 5 p.c. Red. Deb. ...	102—107	...
133,640	Feb. 20	6½	6½	Yorktown (Cam.) 5 p.c. Cons.	115—120	...
120,000	,,	5	5	Do. 5 p.c. Pref.	102—107	...
35,000	Dec. 5	5½	5½	Do. 5½ p.c. Deb.	112—117	...

BRISTOL EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 26.	Rise or Fall on Week.
347,756	Feb. 6	5	6	Bath Cons.	115—117	...
1,667,250	Feb. 6	5	5	Bristol, 5 p.c. max.	105—108	...
120,420	Dec. 19	4	4	Do. 1st 4 p.c. Deb. ...	98—101	...
415,250	,,	4	4	Do. 2nd 4 p.c. Deb. ...	98—101	...
328,790	,,	5	5	Do. 5 p.c. Deb.	115—118	...
274,000	Feb. 20	5	5	Newport (Mon.) 5 p.c. max. ...	95—97	...
13,200	Mar. 20	7	8½	Pontyp'l Gas & W. 10 p.c. 'A'	12½—13½	...
13,600	,,	6	5	Do. 7 p.c. 'B' ...	11½—12	...
40,000	,,	6	5	Do. 7 p.c. 'C' ...	11½—12	...
140,778	Feb. 6	5	5	Weston-super-Mare Cons. ...	103½—105½	...
64,338	Dec. 19	4	4	Do. 4 p.c. Deb. ...	98—101	...
33,340	,,	7½	7½	Do. 7½ p.c. Deb. ..	149—152	...

LIVERPOOL EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 26.	Rise or Fall on Week.
157,150	Feb. 6	5	6½	Chester 5 p.c. Ord.	107—110	...
92,500	Dec. 19	4	4	Do. 4 p.c. Pref.	95—99	...
36,450	,,	3½	3½	Do. 3½ p.c. Deb.	87—90	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb ...	97—101	..
2,167,410	Feb. 20	6	6	Liverpool 5 p.c. Ord.	117—119	...
245,500	Dec. 19	5	5	Do. 5 p.c. Red. Pref. ...	100—105	...
306,083	Jan. 23	4	4	Do. 4 p.c. Deb.... ...	99—101	...
106,280	Feb. 6	10	10	Preston 'A' 10 p.c.	177—187	...
188,219	,,	7	7	Do. 'B' 7 p.c.	129—139	...

NEWCASTLE EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 26.	Rise or Fall on Week.
122,577	Feb. 20	8	8	Blyth 5 p.c. Ord.	157½—158½	...
732,000	Feb. 20	3	3	Hartlepool G. & W. Cn. & New	70—72	+½
2,061,315	Feb. 6	5	5½	Newcastle & Gateshead Con.	20/6–21/3a	+–/4½
682,856	,,	4	4	Do. 4 p.c. Pref. ...	87—89	...
776,706	Dec. 19	3½	3½	Do. 3½ p.c. Deb. ...	87—89	...
277,285	April 24	5	5	Do. 5 p.c. Deb. '43 ...	101—103	...
332,351	Feb. 6	6	6	Sunderland 6 p.c. max. ...	132½—134½	...

NOTTINGHAM EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 26.	Rise or Fall on Week.
542,270	Feb. 6	6	9	Derby Con.	132—137	...
55,000	Dec. 19	4	4	Do. 4 p.c. Deb.	100—105	...
20,000	Dec. 19	5	5	Long Eaton 5 p.c. Pref. ...	10—12	...
80,000	,,	5	5	Do. 5 p.c. Deb. ...	103—108	...

SHEFFIELD EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations May 26.	Rise or Fall on Week.
10,000	Feb. 6	10	10	Great Grimsby 'A' Ord. ...	180—190	...
6,500	,,	10	10	Do. 'B' Ord. ...	180—190	...
79,000	,,	10	10	Do. 'C' Ord. ...	175—185	...
1,806,339	Feb. 20	6½	6½	Sheffield Cons.	137—140	...
95,000	Dec. 19	4	4	Do. 4 p.c. Deb.	100—102	...

a The quotation is per £1 of Stock.
* Ex div.

PUBLISHERS' NOTICE

TERMS OF SUBSCRIPTION

United Kingdom & Ireland : Advance Rate, 35/- per annum ; 18/- per half year. Credit Rate : 40/- per annum ; 21/- per half year.
Dominions & Colonies & United States : 35/- per annum, in advance. Other countries in the Postal Union, 40/- per annum, in advance.

A copy of the "G.J." Calendar and Directory is presented to continuous subscribers.

CLASSIFIED ADVERTISEMENTS

Situations Wanted, 6d. a line (minimum 3/-, about 36 words). Situations Vacant, Plant for Sale and Wanted, Contracts, Public Notices, Educational, &c., 9d. a line (minimum 4/6). Financial Notices, 1/- per line. Box Number, 6d. extra.

WALTER KING, LTD.,

Telephone : Central 2236-7-8. 11, BOLT COURT, FLEET STREET, LONDON, E.C. 4. Telegrams : Gasking, Fleet, London.